City of Santa Fe

Agenda

SANTA FE WATER CONSERVATION COMMITTEE MEETING
CITY HALL – 200 LINCOLN AVE.
CITY COUNCILOR'S CONFERENCE ROOM
December 11, 2018
4:00 PM TO 6:00 PM

1. CALL TO ORDER
2. ROLL CALL
3. APPROVAL OF AGENDA
4. APPROVAL OF CONSENT AGENDA
5. APPROVAL OF MINUTES FROM THE NOVEMBER 13, 2018 MEETING

CONSENT AGENDA:

6. WATER CONSERVATION PROGRAM SCORECARD UPDATE FOR NOVEMBER 2018 (Christine Chavez, Water Conservation Manager, cychavez@santafenm.gov, 955-4219)
7. UPDATE ON CURRENT WATER SUPPLY STATUS (Christine Chavez, Water Conservation Manager, cychavez@santafenm.gov, 955-4219))

INFORMATIONAL ITEMS:

8. 2019 Water Conservation Scorecard (Christine Chavez, Water Conservation Manager, cychavez@santafenm.gov, 955-4219)
9. 2019 Speaker Schedule for Water Conservation Committee Meetings (Christine Chavez, Water Conservation Manager, cychavez@santafenm.gov, 955-4219)

ACTION ITEMS:

10. WORKPLANS TO WATER CONSERVATION SUBCOMMITTEE GROUPS (Christine Chavez, Water Conservation Manager, cychavez@santafenm.gov, 955-4219)

MATTERS FROM PUBLIC:

MATTERS FROM STAFF:

MATTERS FROM COMMITTEE:

NEXT MEETING – (Councilor's Conference Room): TUESDAY, January 8, 2018
CAPTIONS: due by 3:00 pm, FRIDAY December 21, 2018
PACKET MATERIAL: due by 3:00 pm, Wednesday, December 26, 2018

ADJOURN.

Persons with disabilities in need of accommodations, contact the City Clerk's office at 955-6520, five (5) working days prior to meeting date.

RECEIVED AT THE CITY CLERK'S OFFICE
DATE: 12/04/2018
TIME: 4:19 PM

Water Conservation Office

Monthly Overview of Scorecard Progress – November 2018

Education Outreach:

Education Initiative:

- Invitation: Monthly Community Educators Network Meeting 10/31
- Watershed Tours on 11/7, 11/16, 11/26, 11/27 and 11/29
- BDD tours as part of the Passport Program on 11/7
- Staff working with Santa Fe High Green Team on energy and water conservation campaign

General Outreach:

- Green Jobs Fair 10/30/ (Capital High School)

Communication and Customer Service:

Strategic Marketing Plan:

- Radio show guests – Neal Denton, Patricio Pacheco
- Assistance with the 2019 Environmental Services Calendar

Eye On Water Rollout:

- 3,828 sign ups as of 11/19/2018

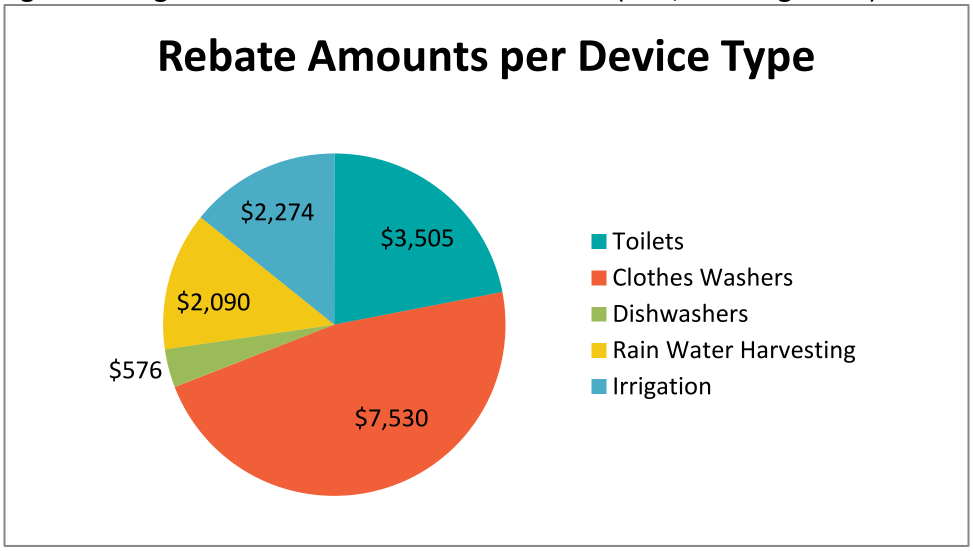
Indoor Water Audits:

none

Enforcement Activity:

- 345- Continuous consumption letters sent

Resedential and Commercial Rebates:
Remaining fund balance as of November 19, 2018: $284,025.02
Water savings resulting from rebates: 1.236634 acre-feet (402,958.43 gallons)



Rebates awarded FY-to-date: 203

- HET (all types) – 70
- Clothes Washers (all types) – 30
- Dishwashers (NEW!) - 16
- Rain Water Harvesting (including rain barrels, cisterns) – 77
- Irrigation (including controllers, audits) (NEW!) - 10

Effective Program Management

Organizational Development:

- Andrew Erdmann selected to fill the Water Conservation Specialist Senior position with a start date of 11/19/2018
- Water Conservation Education and Compliance Specialist position posted with limited candidates. Decision was made to re-write the job description to get more applicants on the list to interview.

Water Conservation Committee:

- Councilor Romero-Wirth reorganizing work done by the Water Conservation Committee
- Water Conservation Committee meeting held on 11/13
- Continuation of Restaurant Pilot project underway

Integration with Water Resources:

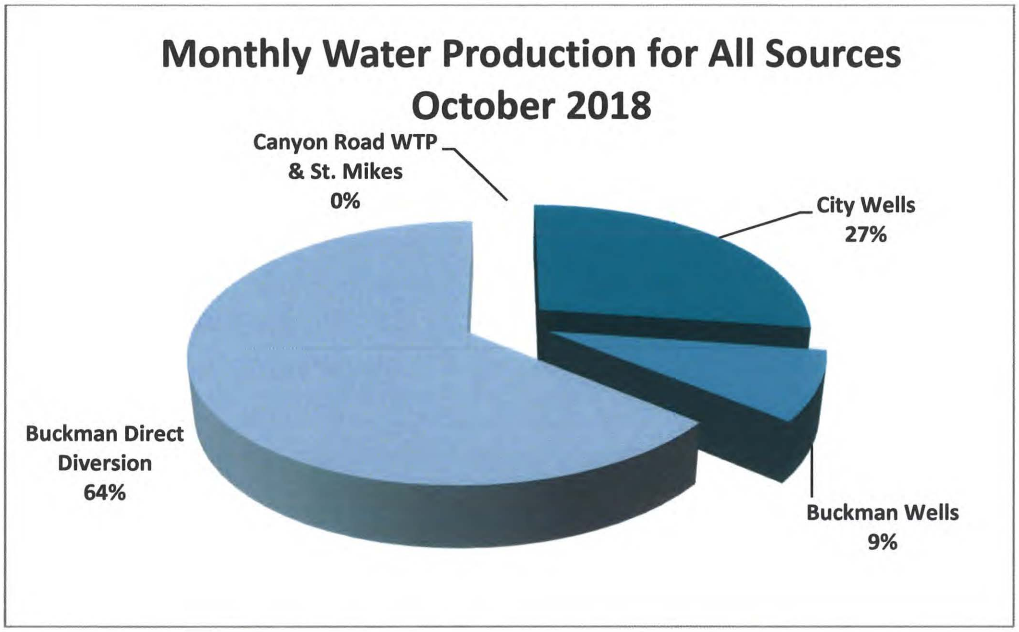
- Water Conservation assisting with the Backflow Prevention Ordinance and 2015 UPC adoption

Stewardship and Conservation:

Regional Collaborations:

- Christine assisting with the planning of the 2019 Next Generation Water Summit
- Water Conservation office hosting the next New Mexico Water Conservation Alliance (NMWCA) meeting on December 13th
- Meeting with the Water Now Alliance on 11/5 on potential partnership on upcoming project

City of Santa Fe, Source of Supply Section
Water Production and Environment Office Update



Total Production of System

Sum: 239 MG million gallons (MG)
Daily Average Production: 7.74 MGD

Reservoir Storage Levels as of November 21, 2018:

McClure:	44.3%	November 20, 2017
Nichols:	68.2%	
Combined:	48.34% or 617.6 MG	46.5%

Santa Fe River Flow:

Below Nichols (Living River Flows):	0.30 cfs
Streamflow at Gage below Nichols:	0.34 cfs (Actual including Living River Flows)
Above McClure (Reservoir Inflow):	4.0 cfs

Water/Environment Update

The Environment Office is collaborating with the New Mexico Environment Department (NMED) to finalize a draft of a draft Source Water Protection Plan (SWPP) prepared in early 2018. A new approach to the SWPP template previously used by the NMED has been suggested by the City, with agreement from that Department. This approach would segregate the source water assessment(s) from the current protection plan which integrates both into one document. The current assessment used in the planning process was completed in 2003 and needs to be updated.

Additional NMED investigations of a potential contaminant source (former dry cleaner) at College Plaza South (2400 Cerrillos Road) are ongoing. A meeting with that department has been scheduled by the City and NMED in early December to discuss additional investigations and measures that need to be considered by NMED with respect to that site, with specific reference to possible plume migration towards City property and wells. The College Plaza South site is an active chlorinated solvent impacted site where chlorinated volatile organic compound (CVOCs) impacts to soil, soil vapor, indoor air and groundwater have been documented by the NMED and a NMED Voluntary Remediation Program (VRP) applicant. Numerous groundwater monitoring wells, nested soil vapor extraction (SVE) wells, and soil vapor monitoring wells have been installed at the site to aid in the delineation of CVOCs in soil, water and air.

Drought/Monsoon, Storage, and ESA Update

The National Ocean and Atmospheric Administration (NOAA) recently updated ENSO (El Nino/La **Niña**) status on October 20, 2018 to:

**"ENSO-neutral conditions are present.
There is ~80% chance of El Niño in the Northern Hemisphere for Fall/Winter 2018-19."**

Heron, Abiquiu, and El Vado reservoir levels on the Chama River are declining rapidly. Runoff for this year is far below normal due to drought conditions. Local Upper Santa Fe River reservoir storage volume is slowly increasing (about 49% full) but water quality has deceased recently due to sediment and algae. The City has received over 90% delivery from the Bureau of Reclamation (BoR) of full firm-yield of San Juan-Chama Project (SJCP) water so far for year 2018. Portions of the middle Rio Grande have begun to dry out. Updates on ESA issues will be made as needed. Rio Grande Compact Article VII storage restrictions are in effect, which means the City is not allowed to impound "native" runoff into Nichols and McClure Reservoirs above the pre-Compact pool of 1,061 acre-feet (AF). Updates to this condition will be made as needed; however, Article VII is expected to stay in effect for the foreseeable future.

Most current City of Santa Fe SJCP Reservoir Storage:

Heron:

9,783 AF.

El Vado:

0 AF.

Abiquiu:

5,360 AF. SJCP carry-over from previous years plus 2018 deliveries. No time limit to vacate due to storage agreement with ABCWUA

TOTAL:

15,143 AF

Journal of Environmental Management 114 (2013) 548–556

Contents lists available at SciVerse ScienceDirect

Journal of Environmental Management

journal homepage: www.elsevier.com/locate/jenvman

Estimating the direct and indirect water use of tourism in the eastern Mediterranean

Michalis Hadjikakou [a,*], Jonathan Chenoweth [a], Graham Miller [b]

[a] Centre for Environmental Strategy, University of Surrey, Guildford, Surrey GU2 7XH, UK
[b] School of Hospitality and Tourism Management, University of Surrey, Guildford, Surrey GU2 7XH, UK

ARTICLE INFO

Article history:
Received 23 July 2012
Received in revised form
29 October 2012
Accepted 4 November 2012
Available online 21 November 2012

Keywords:
Water footprint
Sustainable tourism
Sustainability trade-offs
Water scarcity

ABSTRACT

The impact of tourism activities on local water resources remains a largely understudied issue in environmental and sustainable tourism management. The aim of the paper is to present a simple methodology that allows an estimate of direct and indirect local water use associated with different holiday packages and to then discuss relevant management implications. This is explored through the creation of five illustrative examples of holidays to semi-arid eastern Mediterranean destinations: Cyprus (2), Turkey, Greece and Syria. Using available data on water use associated with different forms of travel, accommodation and tourist activities, indicative water footprints are calculated for each of the illustrative examples. Food consumption by tourists appears to have by far the most significant impact on the overall water footprint and this aspect of water use is explored in detail in the paper. The paper also suggests a way of employing the water footprint methodology along with import/export balance sheets of main food commodities to distinguish between the global and local pressure of tourism demand on water resources. Water resource use is likely to become an increasingly important issue in tourism management and must be considered alongside more established environmental concerns such as energy use, using methodologies that can capture direct as well as supply chain impacts.

1. Introduction

Water issues have been gaining importance on the global political agenda in recent years (UN-Water, 2006; UN-Water, 2010; World Water Assessment Programme, 2009). However, despite water being an issue of global importance, water scarcity issues are inherently local. Water availability on a global scale appears to be sufficient to satisfy human needs, as withdrawals account for less than 10% of the available renewable freshwater resources (Oki and Kanae, 2006). The problem lies in the unequal distribution of global water resources across space and time (Postel et al., 1996). Furthermore, it is often extremely difficult to assess whether water scarcity is caused by insufficient supply or excess demand (Rijsberman, 2006). Demand for water also varies in different places, as it is a factor of development, societal values and human behaviour (Molle and Mollinga, 2003). Policies to manage water resources efficiently must, therefore, be developed locally in order to take into account the context-specific pressures and their interactions.

The impact of tourism on water use, and vice versa, is still an understudied and often overlooked area (Gössling, 2005; Gössling, 2006; Gössling et al., 2012). This is partly because of the fact that environmental sustainability in recent years appears to have become almost synonymous with taking action to limit carbon emissions. On-going attention on climate change has led to an increasing body of research on carbon emissions from tourism, and in particular from air travel (Becken, 2002; Chenoweth, 2009; Gössling, 2000; Gössling et al., 2010b). This research has focused on the importance of both adaptation and mitigation against climate change, highlighting tourism's high dependency on the natural environment and the climate (Scott et al., 2008; Scott and Becken, 2010; Simpson et al., 2008).

Although global warming is, arguably, the most serious environmental concern on a global scale, environmental sustainability is a multifaceted concern. There have been some attempts to calculate the universal impacts of tourism by making use of the Ecological Footprint (EF) concept (Gössling et al., 2002; Hunter, 2002; Hunter and Shaw, 2007), which translates resource

* Corresponding author. Postal Address: Centre for Environmental Strategy, Faculty of Engineering & Physical Sciences, University of Surrey (D3), Guildford, Surrey GU2 7XH, UK. Tel.: +44 0 1483 689074; fax: +44 0 1483 686671.
E-mail address: m.hadjikakou@surrey.ac.uk (M. Hadjikakou).

0301-4797/$ – see front matter
http://dx.doi.org/10.1016/j.jenvman.2012.11.002

consumption and waste generation into an equivalent land area. Although the EF offers a more comprehensive indicator of environmental impact compared to the widely used Carbon Footprint (CF), it still only provides an aggregate measure of environmental impact that does not distinguish between local and global environmental pressures. It must therefore be used alongside other locally based indicators (Hunter and Shaw, 2007). Furthermore, the EF does not explicitly consider water use as water cannot be expressed in terms of global hectares that make up the EF calculation (WWF/ZSL/GFN, 2006).

The increased awareness paid to energy issues should serve as a platform towards better understanding and management of these other environmental pressures. The impact of tourism on water resources should be viewed as a key local sustainability challenge that requires appropriate management interventions, especially in water scarce destinations. The water situation is likely to become more acute in the future with climate change expected to threaten the reliability of both the quantity and quality of water supplies (World Water Assessment Programme, 2009). This provides a further impetus for linking water issues with the existing concern on climate change adaptation.

According to Gössling (2002), the lack of research with a specific focus on water and tourism may also be attributable to a lack of available data. Even within the water policy domain, there has been very limited research on tourism-related water demand compared to other water uses (Tortella and Tirado, 2011). This is due to demand for water from the tourism industry appearing to have a negligible impact compared to other water users such as agriculture, industry and households, with global figures suggesting that international tourism accounts for less than one per cent of national water use (Gössling et al., 2012). However, what this seemingly small figure cannot capture is the spatially and temporally concentrated nature of tourism activity (Emmanuel and Spence, 2009; Essex et al., 2004; Gössling, 2005).

Furthermore, not enough attention has been paid to linkages between tourism and other economic sectors. In a recent publication, Gössling et al. (2012) stress the importance of recognising both direct and indirect water demand from tourism, where direct water use refers to the water used by accommodation and daily activities whereas indirect water use refers to uses such as fossil fuels and diet. Previous studies of water use in the tourism sector have largely focused on water use by tourist infrastructure such as hotels, swimming pools, spas, golf courses and water parks (Charara et al., 2010; De Stefano, 2004; Gössling, 2001; Hof and Schmitt, 2011; Kotios et al., 2009; Rico-Amoros et al., 2009; Tortella and Tirado, 2011), all of which are components of direct water use. Even though the literature does refer to a water demand multiplier effect (Emmanuel and Spence, 2009) whereby increased tourist numbers exert a higher water demand in other economic sectors through consumption of goods and services, no studies have attempted to examine and discuss the implications of this water use in any detail.

The Mediterranean is the world's leading holiday destination with 30% of international arrivals and 25% of global revenues from international tourism (De Stefano, 2004). As a high value user of water, a single day of insufficient water supply could severely affect the public image and reputation of any tourist destination. Water scarcity could become the limiting factor for tourism development, with severe economic consequences (Gössling, 2006). The Mediterranean has been identified as a climate change and water scarcity hotspot (Christensen et al., 2007; Scott et al., 2008). At the same time, tourism arrivals worldwide are expected to maintain an increasing trend in the long term (UNWTO, 2010).

The tourism sector is highly heterogeneous and offers a plethora of different products which cater for different tastes, budgets and times of the year. These different products have different water use implications. Recent studies from Mallorca have shown that the mass tourism product, so often associated with its negative aesthetic impact on the landscape, actually registers much lower water consumption per capita compared to so-called 'quality tourism' (Hof and Schmitt, 2011; Rico-Amoros et al., 2009; Tortella and Tirado, 2011). The principal development of the present paper is to build on these papers by including estimates, for different tourism products, of the indirect water use from different elements of the tourism sector and exploring the role of diet – which according to Gössling et al. (2012) accounts for a significant percentage of total water use. The creation of five hypothetical holiday packages based on a series of assumptions allows the use of published data to explore a methodology that captures both direct and indirect water use. This enables a detailed breakdown of how tourist choices impact water use and highlights important areas to be targeted through management interventions.

The paper is structured as follows: section two reviews the methodology employed in quantifying the impact of tourism on local water resources and recognises important assumptions and necessary limitations inherent in the calculations. Section three compares and discusses the results from the different holiday packages. The final section (section four) concludes the paper by examining in more detail the important elements that account for differences between the holiday packages, and by discussing the importance as well as the practical and policy implications of considering water use alongside other environmental impacts of tourism.

2. Methodology

2.1. Introducing the water footprint and virtual water concepts

A way of accounting for water use by tourism is through the use of the Water Footprint (WF) methodology (Hoekstra, 2003), which has been used to calculate water use on an international (Chapagain and Hoekstra, 2004; Hoekstra and Chapagain, 2007) or corporate scale (Ercin et al., 2011) and to suggest potential ways in which water savings may be achieved. The WF is a consumption-based indicator of water use which divides the footprint of a consumer into water directly consumed for drinking, washing and cooking (operational footprint) plus the water content (embedded water) of all the products consumed (supply-chain or indirect footprint)(Hoekstra et al., 2009). The latter is known as Virtual Water (VW) (Allan, 1998) and essentially refers to the volume of water used to grow, produce, package and ship commodities such as grains and livestock products. Indirect water use far exceeds direct use by around an order of magnitude (Ridoutt and Pfister, 2010).

The WF methodology (Hoekstra et al., 2011) is increasingly being used to illustrate the global dimensions of water consumption (Hoekstra and Mekonnen, 2012), taking into account trade in goods between countries. According to Velázquez et al. (2011), the VW and WF concept can be applied to specific services such as tourism activities. Tourism is not an economic sector in the traditional sense, characterised by its strong backward linkages (purchasing links) with other sectors (Briassoulis, 1991; Dwyer and Forsyth, 2008; Jones and Munday, 2004). Furthermore, with approximately one-third of all tourist expenditure being used to buy food (Gössling et al., 2010a; Torres, 2003), tourists consume a significant amount of VW through their diet. As a sector where products and services are purchased from other sectors and are often shipped in or imported from other regions or countries, tourism appears to be ideally suited to the WF methodology.

Table 1
Hypothetical tourist scenarios used in the study.

Scenario	Location	Accommodation	Local travel means	Diet	Duration
1. Luxury golf holiday	Paphos, Cyprus	5-star hotel	Medium car (2 occupants)	Meat-rich	7 nights
2. Walking/hiking	Polis C., Cyprus	Camping site	Small car (4 occupants)	Vegan	9 nights
3. Budget beach holiday	Bodrum, Turkey	2-star apartment	–	Western diet	9 nights
4. Relaxing beach holiday	Mykonos, Greece	4-star hotel	–	Holiday diet	12 nights
5. Backpacking	Syria	Local house	Public transport	Local diet	28 nights

2.2. Overview of proposed methodology for calculating the WF

Five holiday packages have been constructed (Table 1) and their associated WFs have been calculated using existing secondary data sources. This is similar to the approach followed by Hunter and Shaw (2007) to outline the potential use of the EF in tourism research. Although the holiday packages are hypothetical and should only be seen as indicative, they have been designed in such a way as to allow the reader to appreciate how a range of different choices in terms of transport, accommodation, diet and leisure activities affect water use. Varying the duration of the holiday examples (from a week to a month) allows for a comparison between the daily footprint and the total footprint of each holiday.

Example one (luxury golf holiday) can be considered, at least *a priori*, to be the luxury tourism example, whereas example two (camping holiday) is the more intuitively low impact example. Examples three (budget beach holiday), four (up-market beach holiday) and five (backpacking holiday) are considered to fall in between in terms of luxury and environmental impact intensity, and are in line with commercially available packages offered by travel agencies in the UK. The holiday examples are set in semi-arid destinations in the eastern Mediterranean region. Paphos (Cyprus), Bodrum (Turkey) and Mykonos (Greece) are all mass tourism resorts, especially popular with UK tourists. Turkey, Cyprus and Greece were all in the top ten most searched-for destinations for UK summer departures for 2011, according to the Skyscanner website (Skyscanner, 2011). Polis (Cyprus) is a popular camping destination in the region whereas Damascus is chosen as the base for a longer holiday, where the aim is to travel around Syria for sightseeing and discovering local culture. All chosen destinations already suffer from some degree of water scarcity with serious questions regarding future availability (Chenoweth et al., 2011).

Cyprus and Syria both have available renewable water resources below the water scarcity threshold of 1500–1700 m^3/capita (Falkenmark et al., 1989; Yang et al., 2003). Greece with 7000 m^3/capita (Iglesias et al., 2007) and Turkey with 3280 m^3/capita (Yang et al., 2007) are considerably above this threshold value at the country level. However, most Aegean islands including Mykonos are extremely water scarce (Gikas and Angelakis, 2009; Gikas and Tchobanoglous, 2009; Sofios et al., 2008). Bodrum has been one of the prime international tourism destinations in Turkey in the last two decades (Gezici et al., 2006; Tosun, 2001) and is increasingly faced with water issues. These destinations have also been chosen to allow an appreciation of the role of trade and its potential to minimise impact on local water resources. Cyprus is amongst a group of water scarce countries that have a large external water dependency (Hoekstra and Mekonnen, 2012), with Greece also being a net importer of grains and animal products (FAO, 2010). On the other hand, Turkey and Syria have very low ratios of VW import to renewable resources (Yang et al., 2007).

The basic WF methodology for calculating industrial footprints (Hoekstra et al., 2009, 2011) is applied to tourism by using four principal direct and indirect water use categories as identified in Gössling et al. (2012). The associated WF in l/person/day for each of the five holiday examples is calculated using:

$$\mathrm{WF} = \text{direct WF} + \text{indirect WF} = (\mathrm{AF} + \mathrm{ACF}) + (\mathrm{DF} + \mathrm{FF}) \quad (1)$$

where WF = total water footprint, AF = accommodation footprint, ACF = activity footprint, DF = diet footprint and FF = fuel footprint.

All illustrative examples assume Manchester in the UK as the point of origin. The reason for the choice of Manchester was twofold. Firstly, most people in the UK do not live immediately adjacent to a major international airport such as London Heathrow and thus the selection of a non-London starting point better encompasses the type of journey the majority of tourists are likely to take. Secondly, the south of the UK is technically water scarce as a result of a very high population and limited water resources. By choosing a source region in the north of the country, one can safely assume that the tourist is travelling from a water plentiful area to a water scarce area. Section 2.3 describes the sources of secondary data used as well as methodological considerations and assumptions required for the estimation of each of the terms in Equation (1).

2.3. Water footprint calculations and assumptions

2.3.1. Direct WF

The operational water footprint is composed of the water intensity of the accommodation (AF) and the WF of any activities pursued by the tourist (ACF). AF is the term on which most research has focused to date, both in tourist accommodation (Hof and Schmitt, 2011; Rico-Amoros et al., 2009; Statzu and Strazzera, 2011) and hotels (Bohdanowicz and Martinac, 2007; Charara et al., 2010; Deng and Burnett, 2002; Gössling, 2001). Estimates for different classes of accommodation are usually available through a combination of room numbers and occupancy rates from hotel surveys along with total water consumption from water authorities. However, figures for specific countries are not readily available to allow consistent comparisons and so this study has used figures from Eurostat (Eurostat, 2009).

The estimates for AF for examples one, three and four are based on the Eurostat figures shown in Table 2 for different accommodation types, whereas AF estimates for examples two and five are 84 l/person/day and 197 l/person/day respectively. The latter estimates are based on average figures from campsites in Mallorca (Rico-Amoros et al., 2009), and on 2007 FAO figures for domestic water consumption in Syria (FAO, 2011a) – since this holiday example involves staying in a local house. The estimates are conservative but all fall within the 84–2000 l per person

Table 2
Water consumption standards by accommodation in Morocco (adapted from Eurostat, 2009).

Water consumption standards in Morocco (l/bed-night)	
Luxury 5-star hotel	600
5-star hotel	500
4-star hotel	400
3-star hotel	300
Apartment	180

per day range suggested in Gössling et al. (2012) for tourist accommodation.

An attempt is also made to account for the WF of certain activities that are likely to be pursued in each holiday package through the ACF. Attributing water use from activities such as golf and water parks to individual tourists is challenging. This study made adjustments on the figures suggested by Gössling et al. (2012) who recommend a water footprint of 10–30 l/tourist/day used for tourism-related activities. Examples two, three and five do not entail water-intensive activities and are assigned an average ACF of 20 while example four is assigned an ACF of 30 to reflect visits to water parks and swimming pools.

An exception was made for example one in which golf was the predominant activity. The study used a figure of 3500 m^3 per day from Eurostat (2009) for an 18-hole golf course in a Mediterranean setting, as well as the average number of visitors over the last two years (around 4000) in a popular golf resort in the Paphos area of Cyprus. This works out as 875 l per tourist per day. Golf courses in tourist destinations will cater almost exclusively for tourism demand,[1] meaning that the estimated range in Gössling et al. (2012) may be too conservative when it comes to golf tourism.

2.3.2. Indirect WF

In order to estimate the DF, the study devised hypothetical daily menus suited to each holiday example (see Supplementary Table 1). These variants are, of course, a simplification of the tourist diet, which would be expected to be more varied in reality as the tourist would not be expected to consume the same foods every day. Moreover, we assume that the calorie consumption of each example equals around 3442 k cal, which is the average daily calorie consumption for the UK for 2005–2007 according to the FAO (2011b). This ignores differences in nutritional needs of individuals as well as the fact that, when on holiday, individuals may indulge more in food than they would back at home. However, an average value was required in order to allow comparisons between the different examples.

The menus are made up of ingredients such as eggplants, tomatoes, olive oil, chickpeas, and lentils in addition to grains and meats which feature in popular eastern Mediterranean dishes. It is assumed that tourists consume mostly local dishes. Considering the recent familiarity and popularity of Mediterranean dishes in the UK, this appears to be a reasonable assumption. Using the open source dieting software CRON-O-Meter,[2] the quantities were adjusted to ensure the set caloric intake was met for each example.

In order to perform the calculations, the study uses the virtual water contents (VWCs) for each ingredient (see Supplementary Table 1) as estimated in Mekonnen and Hoekstra (2010a; 2010b; 2011). These figures are expressed in m^3 per ton and include estimates of blue, green and grey water for each agricultural product in each country taking into account local climatic conditions, production efficiencies as well as the origin of imports. Blue water refers to water in rivers, lakes and aquifers (Savenije, 2000). Green water is the soil moisture in the unsaturated soil zone (Falkenmark and Rockström, 1993) and is the main source of water in rain-fed agriculture. Grey water is defined as the volume of water needed to dilute the load of pollutants associated with the production of a certain good or service and is used as an indicator of pollution (Ercin et al., 2011). The present paper considers only the blue and green water components. Grey water was excluded on the grounds that it is a theoretical rather than an actual measured volume (Morrison et al., 2010) which relies heavily on assumptions and estimations (Galli et al., 2012).

The daily DF is given by adding up all the individual VWCs of each ingredient consumed (multiplied by the weights shown in Supplementary Table 1), following Equation (2):

$$\mathrm{DF} = \sum_{i=1}^{n} P_n(\mathrm{BW} + \mathrm{GW}) \tag{2}$$

where P_n = weight of each food product consumed (g), BW = blue water (l/g) and GW = green water (l/g).

The DF requires further manipulation as the study seeks to calculate the local WF component. This distinguishes between food products sourced from within the country and products imported from abroad. The VWC of imported goods is assumed to be equal to that of goods produced within the destination country, which is consistent with the savings perspective defined in Renault (2002). This is a significant assumption, as climate and production efficiencies vary markedly around the world. Nevertheless, in the absence of detailed trade data, this assumption is commonly employed in national and regional WF studies (Zhang et al., 2011; Zhao et al., 2009).

The local diet footprint (LDF) is calculated using the ratio of locally-produced food products as shown in Equation (3) below. It is estimated by dividing the locally-sourced available quantity of a good (local production minus any exports) by the total quantity of a good available in the country (locally-sourced available quantity in addition to imports).[3] The study uses data on production, exports and imports from the FAOSTAT trade balance sheets for 2007 (FAO, 2010). The LDF is found by multiplying the DF by the ratio indicating food produced locally, RLP, as shown in equation (3) below:

$$\mathrm{LDF} = \mathrm{DF} \times \mathrm{RLP} = \mathrm{DF} \times \left(\frac{\mathrm{LP} - E}{\mathrm{LP} - E + I}\right) \tag{3}$$

where LDF = local diet footprint, RLP = ratio of locally-produced food products, LP = locally produced food (tons), E = exports (tons) and I = imports (tons).

An important assumption made is the use of the national trade balance. In reality, the RLP is likely to vary depending on the region as well as between different restaurants and hotels. Furthermore, for pulses, vegetables and fruit, the study has used averaged values for the most commonly eaten products instead of individual commodity values in order to capture a possible range of tourist choices. The drawback of this choice is that these averages cannot account for the wide range of VWCs between products. With regards to animal product consumption, tourists in Cyprus and Greece are assumed to consume equal amounts of all kinds of commonly eaten meat (pork, chicken, beef, lamb and goat) whereas tourists in Syria and Turkey would consume equal amounts of all meat excluding pork which is not eaten in Muslim countries. This ignores personal preferences by providing an averaged value.

The final component of the total WF is the WF associated with fuel, given by FF in Equation (1). Fuel production is particularly water intensive (Wu et al., 2009b). Gössling et al. (2012) propose an estimated requirement of 750 l for every 1000 km of travel by air or car. These are averaged figures and do not take into account variations in factors such as the age of the oil well, the recovery technology employed and the degree of produced water recycling and reuse, all of which are known to significantly affect water

[1] This is confirmed by the high ratio of tourists to permanent members.

[2] Available at http://cronometer.com/.

[3] Note that for animal products an additional correction was also made for the ratio of local to total (including imported) fodder with the exception of goat and lamb which were assumed to have been raised on pastures.

Table 3
Distances used to calculate the WF of travel (Sources: www.webflyer.com for international flights and www.mapcrow.info for intra-country travel).

Origin	Destination	Return distance (km)
Manchester	Larnaca	6920
Manchester	Pafos	6800
Manchester	Bodrum	5800
Manchester	Mykonos	5500
Manchester	London	527
London	Damascus	7120
Larnaca	Pafos	260
Pafos	Polis	80

consumption in oil exploration and production (Wu et al., 2009a). FF is calculated using these estimated figures along with the distances travelled by air (return trip) and public transport or car at the destination shown in Table 3.

2.3.3. Local WF

Using the local LDF (see section 2.3.1), the present study distinguishes between total WF and local WF (LWF). The AF and ACF are assumed to come from local blue water and require no further manipulation. The FF is not considered to be part of the local WF as all countries in the region rely heavily on foreign sources of oil. The LWF is, therefore, calculated using Equation (4).

$$\mathrm{LWF} = \mathrm{LDF} + \mathrm{AF} + \mathrm{ACF} \quad (4)$$

3. Results and discussion

3.1. Water footprints

3.1.1. Individual illustrative example results

3.1.1.1. Example one (luxury golf holiday in Paphos, Cyprus). Example one has the highest percentage of direct WF and is also the example with the lowest DF. This is a result of the luxury accommodation and the activities (golf), which together contribute 16% to the total WF. Example one has the highest daily total WF of all the examples with 8940 l per day, but has a relatively low impact on local water resources (3510 l per day) because of the high percentage of imported food in Cyprus.

3.1.1.2. Example two (camping holiday in Polis, Cyprus). This example has the highest percentage of indirect water use (99%). Example two has by far the lowest local WF (only 1000 l per day) as a result of a lack of animal products in the diet in addition to the budget accommodation and lack of water-intensive facilities. Assuming most food imports come from water-rich countries where agriculture is rain-fed and, recognising that it is the local WF that contributes to water scarcity at the country scale, the choice of accommodation with lower water intensity becomes significant.

3.1.1.3. Example three (budget beach holiday in Bodrum, Turkey). 82% of the total WF is local WF in this example and since accommodation only contributes around 3% to the total WF, this comes mostly from the diet. The LDF is usually inversely correlated to the amount of food imported by the destination countries. This is reflected in the fact that, whilst the daily total WF from example three is low at only 5790 l (with only example four having a lower daily total WF with 5460 l), this example actually has the highest daily local WF with 4750 l.

3.1.1.4. Example four (up-market beach holiday in Mykonos, Greece). In contrast to example three, example four has the highest total WF (65 500 l) but has the lowest daily total WF (5460 l) even though the accommodation was 4-star, mainly because of a low DF. The DF in that case was the lowest of all examples because of moderate meat consumption. Further savings in WF could have been achieved with more basic accommodation as the accommodation makes up 7% of the total WF in this case.

3.1.1.5. Example five (backpacking holiday in Syria). Example five ranks the highest in terms of total WF with 232 000 l, mainly as a result of the longer duration of the holiday. Example five also has the second highest daily total WF with 8290 l, a large part of which is local WF. Under this example, the longer holiday results in a higher overall impact on water resources at the destination. Where the diet is high in meat and the meat tends to be locally produced, as in the case of Syria, the pressure on local water resources is even greater.

3.1.2. Synthesis of results

The final results for each holiday (Table 4) show that indirect WF dominates the WF in all illustrative examples. Most of this comes from the DF which ranges from 75% to 95% of the total WF. AF, although much lower in absolute terms than the DF, accounting for only 1–7% of the total WF, is still an important component because it is always local and requires blue water, which has a higher opportunity cost than green water (Aldaya et al., 2010) as it can be used for both agricultural or non-agricultural activities (Renault, 2002). FF, on the other hand, may account for up to 10% of the total WF as in the case of example three; however this water is rarely local water. The range of daily WFs (5790–8940 l) calculated in this paper is very much in agreement with the figures proposed in Gössling et al. (2012), who suggest a daily WF of 5000–7500 l, with only examples one and five having a slightly higher daily WF compared to the suggested range.

3.2. The importance of the diet footprint

As the most significant component of the overall WF, the DF is explored in more detail in Fig. 1. In Fig. 1a and b, the total WF is split into local green water, local blue water, total green water and total blue water. Fig. 1a shows that, with the exception of example two, the green water content of food exceeds blue water by around ten times. It also highlights the fact that Cyprus (examples one and two) and Greece (example four) import a significant percentage of

Table 4
Water footprints for each hypothetical scenario.

Scenario	DF		AF		FF		ACF		Local WF		Total H_2O	H_2O/day
	m^3	%	m^3	%	m^3	%	m^3	%	m^3	%	m^3	m^3
1	46	75	4.4	7	5.6	9	5.6	9	24.6	39	62.6	8.94
2	56.6	91	0.6	1	5.1	8	0	<0.5	9.04	14	63.8	7.08
3	45.3	87	1.6	3	5.2	10	0	<0.5	42.7	82	52.1	5.79
4	56.3	86	4.6	7	4.6	7	0	<0.5	31.5	48	65.5	5.46
5	220.4	95	4.6	2	7.0	3	0	<0.5	12.5	54	232	8.29

Where DF = diet footprint, AF = accommodation footprint, FF = fuel footprint, ACF = activity footprint. Note: 1 m^3 = 1000 l.

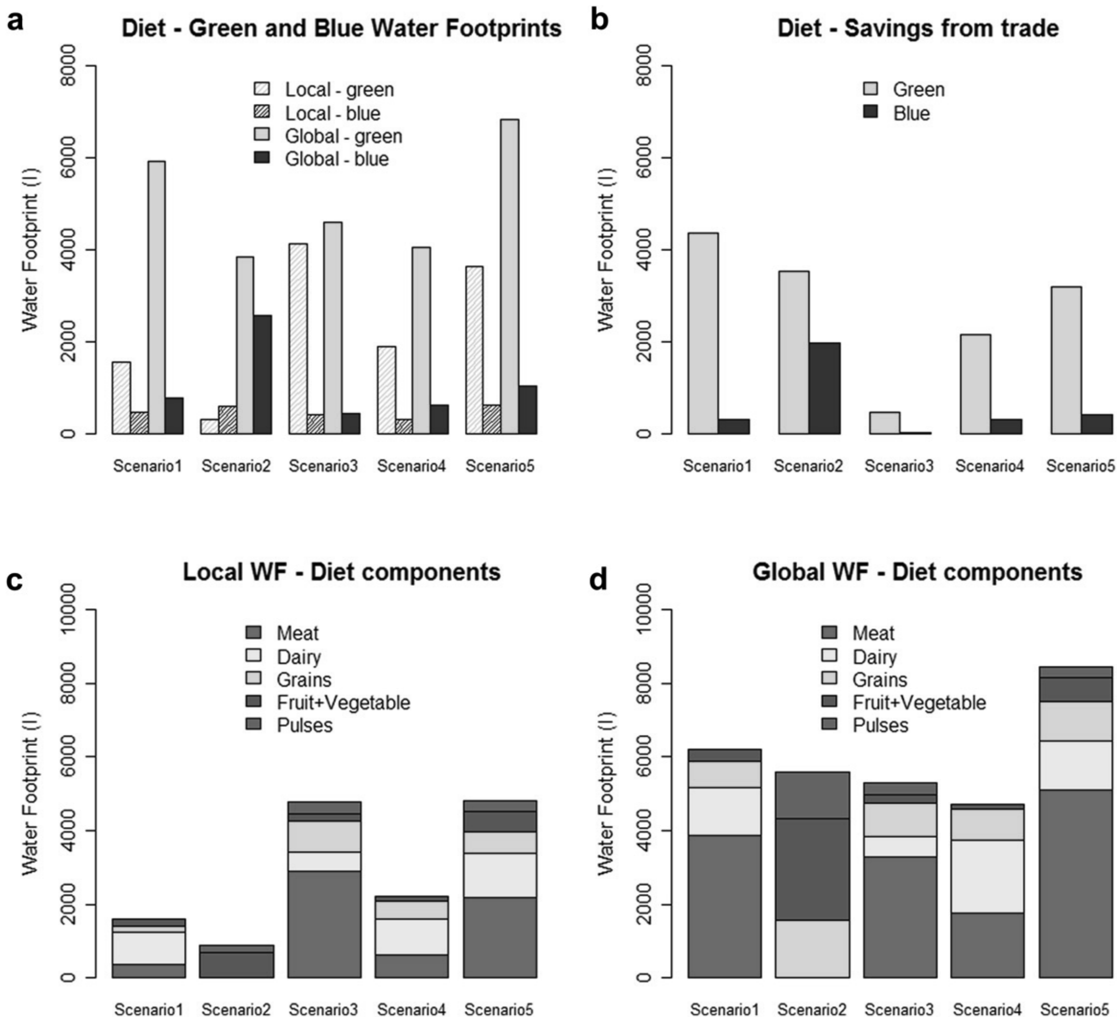


Fig. 1. Detailed water footprints for each of the different holiday scenarios. Data from menus in table V are plotted to show the relative contribution of blue and green water as well as contribution of different food groups. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

the food they consume. Subtracting local blue water and local green water from total blue water and total green water respectively, reveals the amount of local water 'saved'[4] from importing food, as shown in Fig. 1b. Example three (Turkey) registers much lower savings from trade compared to the other examples. Fig. 1c and d show the combined total (green and blue) for each of the examples, divided into the different diet components. This highlights the fact that animal products such as meat and dairy are significantly more water intensive compared to plant-derived products.

Meat and dairy account for over 75% of the DF in all the holiday packages except example two (vegan diet). Comparing, for instance, the local WF against the total WF of examples one and five shows how water intensive meat imports are, as they account for more than 50% of the total WF. This is illustrated by the significant green water savings in Fig. 1b. Fruit and vegetables in the vegan example (example two) appear to have a surprisingly high total WF. This also translates into high green and blue water savings (fruit and vegetables tend to be irrigated in the Mediterranean) as shown in Fig. 1b. The unexpectedly high DF in example two is mostly a result of pulses and vegetables in Cyprus having very high WFs (especially blue WF) according to the figures in Mekonnen and Hoekstra (2010a, 2010b, 2011).

Diet appears to stand out as an obvious area that warrants further research. Estimating the DF for different tourist groups would require extensive interviewing to determine food preferences, something visitation surveys are currently unlikely to cover in sufficient detail. Sourcing local food is usually seen as a means to promote economic linkages between tourism and agriculture, thus enhancing the benefits of tourism to the economy (Soler, 2008; Telfer and Wall, 1996; Torres, 2003). However, attempts to boost local production and reduce economic leakage could contribute to water shortage at the destination, especially where tourists demand products that are unsuitable to local environmental conditions. Destinations in arid places can maximise economic return in certain cases by importing water-intensive agricultural products from abroad to complement investments in more water-efficient accommodation. Nevertheless, high energy embodied in imported products could result in a large additional CF. Where food is sourced from has significant repercussions on the WF, the CF as well as the number of jobs likely to be impacted in the agricultural sector.

[4] Even though the import of virtual water cannot actually result in real water savings (Antonelli et al., 2012; Wichelns, 2010a), the option to import food products is assumed to provide water scarce countries with improved food and water security (Antonelli et al., 2012).

3.3. WF considered alongside other environmental impacts: management implications

Tourists are often unaware of local water scarcity and cannot be expected to compromise the quality of their hard-earned holiday by making pro-environmental choices (Miller et al., 2010). Improving the inherent efficiency with which the tourism sector uses water becomes a key requirement not only to minimise the impact of the sector on the environment but also to ensure its survival through continued use of the resource. Moreover, any attempt or policy aimed at reducing the water impact of tourism must be compatible with other sustainability targets such as carbon emissions reduction.

Many policies that promote energy savings also bring water savings. This is seen in areas in accommodation facilities and hotels where there is a strong financial incentive to conserve both water and energy (Deng and Burnett, 2002). It is also well understood that an increasing range of facilities such as water parks and golf courses requires additional energy and water (including non-conventional sources such as desalination) to operate (Abrams and Hall, 2010; Gleick, 1994; Griffiths-Sattenspiel and Wilson, 2009). However, water and energy use in areas such as diet, fuel and activities are not as well understood partly because the majority of the footprint lies in the supply-chain. This creates both synergies and trade-offs between water and energy savings.

The diet footprint is one of the most complex areas. The overall quantity consumed as well as the percentage of animal products are directly correlated with higher energy and water use. The results show that recommendations from Gössling et al. (2010a) aimed at lowering tourism's food-associated CF such as promoting vegetarian dishes, reducing portions, minimising waste, buying less rice and beef while buying more potatoes, chicken and pork in their place would, in most cases, also lead to a lower WF. On the other hand, as previously discussed, imported products can have high CFs, creating a trade-off in relation to the local water savings.

Other potential trade-offs are biofuels and non-conventional water uses such as desalination and wastewater treatment. Research has shown that any assessments of bioenergy potentials must also consider the increase in demand for land and scarce water resources (Berndes, 2002). Similarly, desalination or reclaimed water may help satisfy local water needs (Liu et al., 2012) and alleviate pressure on water bodies and ecosystems (Kalavrouziotis and Drakatos, 2004) but require considerable energy. Appreciating potential synergies and trade-offs between proposed energy- and water-saving practices requires that the full spectrum of water impacts is explored and understood in a local context.

3.4. Assumptions, limitations and future method refinements

This paper provides an example of how currently available data may be used to estimate the WF of different tourism choices. The paper has built on recent work by Gössling et al. (2012) who have highlighted that even though direct water use may appear to be more relevant for water management at the destination, indirect water use accounts for the majority of the overall amount of water used. By breaking down the individual components of direct and indirect use and applying them to different holiday packages, the approach has allowed further emphasis on the role of food consumption as the most significant form of indirect water use.

The present paper makes an original contribution to understanding how a combination of factors such as dietary choices, local water scarcity, local agricultural efficiency and the import/export balance of food commodities play determine the overall impact on water resources at the destination region. Nevertheless, the significant number of assumptions and the results obtained also highlight that this methodology is somewhat simplistic and should only be seen as a first step in the right direction. As Hunter and Shaw (2007) previously concluded with regards to the EF, this study highlights the need to collect 'real world' primary data for water resources consumed along the whole supply chain of tourism products and services.

Another important consideration is that the VW and WF concepts have received some criticism on the grounds that they fail to recognise the significance of factors other than water availability, such as land endowments or other inputs, which influence policy decisions with regards to the production and trade of commodities (Gawel and Bernsen, 2011; Wichelns, 2010a, 2010b). This is a valid argument and, for this reason, the WF is a useful water accounting concept best used alongside other indicators of environmental impact.

The estimated WF in this paper is the gross WF as opposed to a net WF that would subtract the WF used had the tourist remained at home during the trip from the calculated figures. Gössling (2006) and Gössling et al. (2012) have argued that, even though on a global level tourism tends to shift water consumption from water-rich to water-poor areas, the water saved in the source regions partly compensates for overuse of local water resources in the destination regions. However, water scarcity is largely a local problem and water saved in the source regions does not benefit local water problems at the destination. Consequently, the net footprint concept is more relevant for indicators of global environmental impact such as EF and CF with the gross footprint being more relevant for indicators of local environmental impact such as the WF at the destination.

Life-cycle thinking allows policymakers and destination managers to better appreciate synergies and trade-offs between policies which are often designed to promote either sustainable energy use or sustainable water use. Few studies to date have considered environmental impacts (including both carbon emissions and water use) from the entire supply side chain in addition to onsite impacts (Lundie et al., 2007; Patterson and McDonald, 2004). Considering the combination of impacts is the direction in which future studies need to be undertaken. Furthermore, a more comprehensive analysis requires that the impacts of tourism on water and energy are considered in relation to the economic costs and benefits of tourism. This allows estimates of eco-efficiency (Becken and Patterson, 2006; Gössling et al., 2002) and water productivity (Gleick, 2003) that estimate trade-offs between profitability and environmental impacts of different types of tourism.

Sustainable tourism management must be seen as an important part of the broader environmental management domain. Travelling for business and leisure has become an important aspect of life in the developed world, and is also rapidly on the increase in the developing world (UNWTO, 2010). A holiday often comes as a hard-earned break and may result in a more extravagant consumption behaviour compared to consumption patterns at home. In an environmental sustainability sense, tourism can be viewed as a spatially and temporally explicit increase in population which, in most cases, is composed of individuals whose consumption patterns are likely to have higher environmental impact than those of local residents. Especially in places where tourism is an important economic activity, tourism must be seen as a significant user of water and other environmental resources and both direct and indirect impacts must be quantified and managed to maintain sustainable consumption patterns.

4. Conclusion and summary

The study highlights the importance of indirect water use in the tourism sector as well as the potential of life-cycle type water footprint calculations to complement existing CF and EF methodologies. The methodology outlined in the article has suggested ways in which to account for both the global and the local pressure of tourism demand on water resources using the import/export balance in food commodities. It has also explored the aspect of diet in more detail in order to understand how different elements of tourists' diets contribute to the overall footprint. The illustrative examples used in this paper have had to be based on several assumptions regarding tourist diet and choices. It is envisaged that additional primary data (through detailed visitation surveys and environmental audits at the resort scale) will allow further development of the methodology proposed in this study. This would then allow for more reliable estimates of the WF of different types of tourist.

A combination of a flight closer to home and a largely vegetarian diet can make a significant difference in lessening the overall impact of a holiday example. The type of accommodation appears to be the second most important factor that contributes to a more sustainable holiday, with budget accommodation having much lower footprints compared to luxury accommodation. Diet is, perhaps, easier and more readily modified compared to flight or accommodation choices. Bearing in mind the magnitude of the indirect water demand of tourism related to food consumption, policymakers and destination managers are faced with the challenge of managing this demand more sustainably, whilst also ensuring that tourist satisfaction remains largely unaffected.

Water use has so far been neglected compared to carbon but is likely to become an important parameter of sustainable tourism in the foreseeable future, not only where water is currently scarce but also where climate change is expected impact local water resources. Estimates like those presented in this paper are only the very beginning of this process, and greater refinement of the methodology and collection of data are certainly needed.

Appendix A. Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.jenvman.2012.11.002.

References

Abrams, R.H., Hall, N., 2010. Framing water policy in a carbon affected and carbon constrained environment. Nat. Resour. J. 50, 70.

Aldaya, M., Allan, J., Hoekstra, A., 2010. Strategic importance of green water in international crop trade. Ecol. Econ. 69, 887–894.

Allan, J.A., 1998. Virtual water: a strategic resource global solutions to regional deficits. Ground Water 36, 545–546.

Antonelli, M., Roson, R., Sartori, M., 2012. Systemic input–output computation of green and blue virtual water 'flows' with an illustration for the Mediterranean region. Water Resour. Manage. 26, 4133–4146.

Becken, S., 2002. Analysing international tourist flows to estimate energy use associated with air travel. J. Sustain. Tourism 10, 114–131.

Becken, S., Patterson, M., 2006. Measuring national carbon dioxide emissions from tourism as a key step towards achieving sustainable tourism. J. Sustain. Tourism 14, 323–338.

Berndes, G., 2002. Bioenergy and water – the implications of large-scale bioenergy production for water use and supply. Global Environ. Change 12, 253–271.

Bohdanowicz, P., Martinac, I., 2007. Determinants and benchmarking of resource consumption in hotels – case study of Hilton International and Scandic in Europe. Energy Build 39, 82–95.

Briassoulis, H., 1991. Methodological issues: tourism input–output analysis. Ann. Tourism Res. 18, 485–495.

Chapagain, A.K., Hoekstra, A.Y., 2004. Water Footprints of Nations. UNESCO-IHE, Delft, The Netherlands.

Charara, N., Cashman, A., Bonnell, R., Gehr, R., 2010. Water use efficiency in the hotel sector of Barbados. J. Sustain. Tourism 19, 231–245.

Chenoweth, J., 2009. Is tourism with a low impact on climate possible? Worldwide Hospitality and Tourism Themes 1, 274–287.

Chenoweth, J., Hadjinicolaou, P., Bruggeman, A., Lelieveld, J., Levin, Z., Lange, M.A., Xoplaki, E., Hadjikakou, M., 2011. Impact of climate change on the water resources of the eastern Mediterranean and Middle East region: modeled 21st century changes and implications. Water Resour. Res. 47, W06506.

Christensen, J., Hewitson, B., Busuioc, A., Chen, A., Gao, X., Held, R., Jones, R., Kolli, R., Kwon, W., Laprise, R., 2007. Regional Climate Projections, Climate Change, 2007: the Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge.

De Stefano, L., 2004. Freshwater and Tourism in the Mediterranean. WWF Mediterranean programme, Rome.

Deng, S.M., Burnett, J., 2002. Water use in hotels in Hong Kong. Int. J. Hospitality Manage. 21, 57–66.

Dwyer, L., Forsyth, P., 2008. Economic measures of tourism yield: what markets to target? Int. J. Tourism Res. 10, 155–168.

Emmanuel, K., Spence, B., 2009. Climate change implications for water resource management in Caribbean tourism. Worldwide Hospitality and Tourism Themes 1, 252–268.

Ercin, A.E., Aldaya, M.M., Hoekstra, A.Y., 2011. Corporate water footprint accounting and impact assessment: the case of the water footprint of a sugar-containing carbonated beverage. Water Resour. Manage. 25, 721–741.

Essex, S., Kent, M., Newnham, R., 2004. Tourism development in Mallorca: is water supply a constraint? J. Sustainable Tourism 12, 4–28.

Eurostat, 2009. MEDSTAT II: 'Water and Tourism' Pilot Study. European Commission, Luxembourg.

Falkenmark, M., Lundqvist, J., Widstrand, C., 1989. Macro-scale water scarcity requires micro-scale approaches. Nat. Resour. Forum 13, 258–267.

Falkenmark, M., Rockström, J., 1993. Curbing rural exodus from tropical drylands. Ambio. Stockholm 22, 427–437.

FAO, 2011a. AQUASTAT – FAO's Information System on Water and Agriculture, 2011 [online] URL: http://www.fao.org/nr/water/aquastat/main/index.stm (accessed 02.04.11.).

FAO, 2011b. FAO Statistical Yearbook 2010 [online] URL: http://www.fao.org/economic/ess/ess-publications/ess-yearbook/ess-yearbook2010/en/ (accessed 17.07.12.).

FAO, 2010. FAOSTAT 2007 Food Balance Sheets for Cyprus, Syria, Greece and Turkey [online] URL: http://faostat.fao.org/site/368/default.aspx#ancor (accessed: 18.01.12.).

Galli, A., Wiedmann, T., Ercin, E., Knoblauch, D., Ewing, B., Giljum, S., 2012. Integrating ecological, carbon and water footprint into a "Footprint Family" of indicators: definition and role in tracking human pressure on the planet. Ecol. Indic. 16, 100–112.

Gawel, E., Bernsen, K., 2011. Do we really need a water footprint? Global trade, water scarcity and the limited role of virtual water. GAIA-Ecological Perspectives for Science and Society 20, 162–167.

Gezici, F., Gül, A., Alkay, E., 2006. In: Brebbia, C., Pineda, F. (Eds.), Evaluating Tourism Development Models for Bodrum Peninsula in Turkey. Sustainable Tourism II. WIT Press, Southampton, pp. 273–283.

Gikas, P., Angelakis, A.N., 2009. Water resources management in Crete and in the Aegean Islands, with emphasis on the utilization of non-conventional water sources. Desalination 248, 1049–1064.

Gikas, P., Tchobanoglous, G., 2009. Sustainable use of water in the Aegean Islands. J. Environ. Manage. 90, 2601–2611.

Gleick, P.H., 2003. Water use. Annu. Rev. Environ. Resour. 28, 275–314.

Gleick, P.H., 1994. Water and energy. Annu. Rev. Energy Environ. 19, 267–299.

Gössling, S., 2006. Tourism and water. In: Gossling, S., Hall, C.M. (Eds.), Global Environmental Change, Ecological, Social, Economic and Political Interrelationships. Routledge, Abingdon, pp. 180–194.

Gössling, S., 2005. Tourism's contribution to global environmental change: space, energy, disease, and water. In: Hall, C.M., Higham, J.E.S. (Eds.), Tourism, Recreation, and Climate Change. Channel View Books, Clevedon, pp. 286–300.

Gössling, S., 2002. Global environmental consequences of tourism. Global Environ. Change 12, 283–302.

Gössling, S., 2001. The consequences of tourism for sustainable water use on a tropical island: Zanzibar, Tanzania. J. Environ. Manage. 61, 179–191.

Gössling, S., 2000. Sustainable tourism development in developing countries: some aspects of energy use. J. Sustain. Tourism 8, 410–425.

Gössling, S., Garrod, B., Aall, C., Hille, J., Peeters, P., 2010a. Food management in tourism: reducing tourism's carbon 'foodprint'. Tourism Manage. 32, 534–543.

Gössling, S., Hall, C.M., Peeters, P., Scott, D., 2010b. The future of tourism: can tourism growth and climate policy be reconciled? A climate change mitigation perspective. Tourism Recreation Res. 35, 119–130.

Gössling, S., Hansson, C.B., Hörstmeier, O., Saggel, S., 2002. Ecological footprint analysis as a tool to assess tourism sustainability. Ecol. Econ. 43, 199–211.

Gössling, S., Peeters, P., Hall, C.M., Ceron, J.P., Dubois, G., Lehmann, L.V., Scott, D., 2012. Tourism and water use: supply, demand, and security. An international review. Tourism Manage. 33, 1–15.

Griffiths-Sattenspiel, B., Wilson, W., 2009. The Carbon Footprint of Water. River Network, Portland.

Hoekstra, A.Y., 2003. Virtual Water Trade, Value of Water Research Report Series No. 12. IHE Delft, Delft, The Netherlands.

Hoekstra, A.Y., Chapagain, A.K., 2007. Water footprints of nations: water use by people as a function of their consumption pattern. Water Resour. Manage. 21 (1), 35–48.

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

Hoekstra, A.Y., Chapagain, A.K., Aldaya, M.M., Mekonnen, M.M., 2009. Water Footprint Manual, State of the Art.

Hoekstra, A.Y., Mekonnen, M.M., 2012. The water footprint of humanity. PNAS 109, 3232–3237.

Hof, A., Schmitt, T., 2011. Urban and tourist land use patterns and water consumption: evidence from Mallorca, Balearic Islands. Land Use Policy 28, 792–804.
Hunter, C., 2002. Sustainable tourism and the touristic ecological footprint. Environ. Dev. Sustainability 4, 7–20.
Hunter, C., Shaw, J., 2007. The ecological footprint as a key indicator of sustainable tourism. Tourism Manage. 28, 46–57.
Iglesias, A., Garrote, L., Flores, F., Moneo, M., 2007. Challenges to manage the risk of water scarcity and climate change in the Mediterranean. Water Resour. Manage. 21, 775–788.
Jones, C., Munday, M., 2004. Evaluating the economic benefits from tourism spending through input–output frameworks: issues and cases. Local Economy 19, 117–133.
Kalavrouziotis, I.K., Drakatos, P.A., 2004. Investigation of Corfu-Greece reclaimed municipal wastewater suitability for irrigation. Int. J. Water 2, 284–296.
Kotios, A., Plageras, P., Galanos, G., Koutoulakis, M., Saratsis, Y., 2009. The impact of tourism on water demand and wetlands: searching for a sustainable coexistence. Discussion Paper Series 15 (4), 71–88.
Liu, S., Papageorgiou, L.G., Gikas, P., 2012. Integrated management of non-conventional water resources in anhydrous islands. Water Resour. Manage. 26, 359–375.
Lundie, S., Dwyer, L., Forsyth, P., 2007. Environmental-economic measures of tourism yield. J. Sustain. Tourism 15, 503–519.
Mekonnen, M., Hoekstra, A., 2011. National Water Footprint Accounts: the Green, Blue and Grey Waterfootprint of Production and Consumption. In: Value of Water Research Report Series No. 50. IHE Delft, Delft, The Netherlands.
Mekonnen, M., Hoekstra, A., 2010a. The Green, Blue and Grey Water Footprint of Crops and Derived Crop Products. In: Value of Water Research Report Series No. 47. IHE Delft, Delft, The Netherlands.
Mekonnen, M., Hoekstra, A., 2010b. The Green, Blue and Grey Water Footprint of Farm Animals and Animal Products. In: Value of Water Research Report Series No. 48. IHE Delft, Delft, The Netherlands.
Miller, G., Rathouse, K., Scarles, C., Holmes, K., Tribe, J., 2010. Public understanding of sustainable tourism. Ann. Tourism Res. 37, 627–645.
Molle, F., Mollinga, P., 2003. Water poverty indicators: conceptual problems and policy issues. Water Policy 5, 529–544.
Morrison, J., Schulte, P., Schenck, R., 2010. Corporate Water Accounting: an Analysis of Methods and Tools for Measuring Water Use and Its Impact. UNEP/Pacific Institute, Oakland.
Oki, T., Kanae, S., 2006. Global hydrological cycles and world water resources. Science 313, 1068.
Patterson, M., McDonald, G., 2004. How Clean and Green Is New Zealand Tourism? Lifecycle and Future Environmental Impacts. In: Landcare Research Science Series No. 24. New Zealand, Lincoln.
Postel, S.L., Daily, G.C., Ehrlich, P.R., 1996. Human appropriation of renewable fresh water. Science 271, 785.
Renault, D., 2002. Value of Virtual Water in Food: Principles and Virtues. UNESCO-IHE, Delft, the Netherlands.
Rico-Amoros, A.M., Olcina-Cantos, J., Sauri, D., 2009. Tourist land use patterns and water demand: evidence from the Western Mediterranean. Land Use Policy 26, 493–501.
Ridoutt, B.G., Pfister, S., 2010. A revised approach to water footprinting to make transparent the impacts of consumption and production on global freshwater scarcity. Global Environ. Change 20, 113–120.
Rijsberman, F.R., 2006. Water scarcity: fact or fiction? Agric. Water Manage. 80, 5–22.
Savenije, H.H.G., 2000. Water scarcity indicators; the deception of the numbers, physics and chemistry of the earth, part B: hydrology. Oceans and Atmosphere 25, 199–204.
Scott, D., Amelung, B., Becken, S., Ceron, J.P., Dubois, G., Gossling, S., Peeters, P., Simpson, M., 2008. Climate Change and Tourism: Responding to Global Challenges. World Tourism Organization, Madrid.
Scott, D., Becken, S., 2010. Adapting to climate change and climate policy: progress, problems and potentials. J. Sustain. Tourism 18, 283–295.
Simpson, M.C., Gössling, S., Scott, D., Hall, C.M., Gladin, E., 2008. Climate Change Adaptation and Mitigation in the Tourism Sector: Frameworks, Tools and Practices. In: Climate Change Adaptation and Mitigation in the Tourism Sector: Frameworks, Tools and Practices. UNEP/University of Oxford/UNWTO/WMO, Paris.
Skyscanner, 2011. Balkans Booming; Brits Travel Plans for Summer Revealed by Skyscanner [online] URL: http://www.skyscanner.net/news/articles/2011/05/009702-balkans-booming-brits-travel-plans-for-summer-revealed-by-skyscanner.html (accessed 15.03.12.).
Sofios, S., Arabatzis, G., Baltas, E., 2008. Policy for management of water resources in Greece. The Environmentalist 28, 185–194.
Soler, M.A.S., 2008. The economic value of water and its implications in the Mediterranean Basin. In: IEMed (Ed.), Mediterranean Yearbook 2008. European Institute of the Mediterranean (IEMed), Barcelona, pp. 111–117 [online] URL: http://www.iemed.org/anuari/2008/asumari.php.
Statzu, V., Strazzera, E., 2011. A panel data analysis of residential water demand in a Mediterranean tourist region. In: Cerina, F., Markandya, A., McAleer, M. (Eds.), Economics of Sustainable Tourism. Routledge, Abingdon, pp. 58–75.
Telfer, D.J., Wall, G., 1996. Linkages between tourism and food production. Ann. Tourism Res. 23, 635–653.
Torres, R., 2003. Linkages between tourism and agriculture in Mexico. Ann. Tourism Res. 30, 546–566.
Tortella, B.D., Tirado, D., 2011. Hotel water consumption at a seasonal mass tourist destination. The case of the island of Mallorca. J. Environ. Manage. 92, 2568–2579.
Tosun, C., 2001. Challenges of sustainable tourism development in the developing world: the case of Turkey. Tourism Manage. 22, 289–303.
UN-Water, 2010. Climate Change Adaptation: the Pivotal Role of Water [report available online] URL: http://www.unwater.org/documents.html.
UN-Water, 2006. Coping With Water Scarcity: a Strategic Issue and Priority for System-wide Action [report available online] URL: http://www.unwater.org/documents.html.
UNWTO, 2010. UNWTO Tourism Highlights 2010 Edition. UN World Tourism Organization, Madrid.
Velázquez, E., Madrid, C., Beltrán, M.J., 2011. Rethinking the concepts of virtual water and water footprint in relation to the production–consumption binomial and the water–energy nexus. Water Resour. Manage. 25, 743–761.
Wichelns, D., 2010a. Virtual water and water footprints offer limited insight regarding important policy questions. Water Resour. Dev. 26, 639–651.
Wichelns, D., 2010b. Virtual water: a helpful perspective, but not a sufficient policy criterion. Water Resour. Manage. 24, 2203–2219.
World Water Assessment Programme, 2009. The United Nations World Water Development Report 3: Water in a Changing World. Earthscan, London.
Wu, M., Mintz, M., Wang, M., Arora, S., 2009a. Consumptive Water Use in the Production of Ethanonl and Petroleum Gasoline. ANL/ESD/09–1. Centre for Transportation Research, Energy Systems Division, Argonne National Laboratory (ANL), Argonne, Illinois.
Wu, M., Mintz, M., Wang, M., Arora, S., 2009b. Water consumption in the production of ethanol and petroleum gasoline. Environ. Manage. 44, 981–997.
WWF/ZSL/GFN, 2006. Living Planet Report 2006. WWF International/Institute of Zoology/Global Footprint Network.
Yang, H., Reichert, P., Abbaspour, K.C., Zehnder, A.J.B., 2003. A water resources threshold and its implications for food security. Environ. Sci. Technol. 37, 3048–3054.
Yang, H., Wang, L., Zehnder, A.J.B., 2007. Water scarcity and food trade in the Southern and Eastern Mediterranean countries. Food Policy 32, 585–605.
Zhang, Z., Yang, H., Shi, M., 2011. Analyses of water footprint of Beijing in an interregional input–output framework. Ecol. Econ., 2494–2502.
Zhao, X., Chen, B., Yang, Z., 2009. National water footprint in an input–output framework – a case study of China 2002. Ecol. Model. 220, 245–253.