The water footprint of a hotel's food consumption

IMPROVING THE METHODS FOR CALCULATING THE INDIRECT WATER FOOTPRINT OF A HOTEL

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Abstract

Tourism is a growing business in the world, which requires big numbers of freshwater in its facilities and services (Charara et al., 2011). With emerging water issues in popular tourism destinations, it is important that water consumption is managed adequately, and in order to do so it is important to know in what ways the water is used exactly.
Until now, most research has focussed on the water that is used on site at the tourism destination, but the water that is used during the production of certain goods and services that are consumed at the tourism destination remains inadequately understood. One of those goods which consume big amounts of water in the production process is the food which is served in restaurants of hotels (Bohdanowicz & Martinac, 2007; Yang et al., 2011). This study tries to fill a gap in the literature by researching the water that is used for the production of food that is consumed at a hotel. It does this by making a first attempt at applying the Water Footprint methodology, introduced by Hoekstra and Hung (2002), to a hotel situated in The Netherlands. Two approaches were tested and resulted to show a good representation of the overall water footprint of the hotel's food consumption. However, difficulties were encountered which should be overcome, and improvements should be made to use this methodology in future research.

Key words: tourism, water footprint, indirect water use, food consumption, hotel

Contents

1. Introduction

Water is a vital resource for all life on earth. But apart from that, it is also a vital resource in tourism. With more and more knowledge that is gathered about the current climate change, it becomes clear that the amount of freshwater in the world is being threatened in certain parts of the world. It is expected that the pressure on freshwater resources will increase because of the impacts of climate change. This could lead to several social and environmental problems (Jeswani & Azapagic, 2011), making water the problem of the twenty-first century, according to international organizations (Kasim et al., 2014). This while the demand for water is growing significantly around the world, meaning that water is becoming more and more a global resource (Hoekstra, 2008), since more and more people around the world are getting more dependent on it.

Not only residents in arid areas have to deal with the consequences of climate change, also tourists and tourist resorts have to deal with this reduced water availability which is caused both by a growing water demand because of growing tourism numbers, and rising temperatures as a result of climate change, which cause more droughts in periods of low rainfall, leading to a lower water supply (Hof & Schmitt, 2011). This limited availability of clean water is a big concern for the tourism industry in several parts of the world (Kasim et al., 2014).
Since tourism is one of the largest industries in the world (Hunter, 2002), and also the fastest growing industry in the world (WTTC, 2011), which requires large amounts of water, it is important that attention is paid to the ways in which the water is used in the sector. Especially since tourism does not only use the water, but it often also depletes or pollutes water resources (Yang et al., 2011). This is more and more becoming a problem for the sustainability of the water supply in tourist areas (Kent et al., 2002). However, it is still quite unclear what the water consumption of tourists exactly looks like. Until now, most studies have examined sustainable tourism of the destination area itself, and less attention was paid to individual tourism activities at a destination (Hunter, 2002). Therefore, this study will make an attempt at calculating the water consumption of a specific part of the tourism sector, namely a hotel.

The Water Footprint is an approach which was first introduced by Hoekstra and Hung (2002), and it is used to get an insight in the water that is used for the production of individual products, or that is used by companies or entire nations. By using it, it is possible to find out for what purposes the world's fresh water is used and polluted. The water footprint approach looks at water that is used directly, and water that is used indirectly. The direct water footprint looks at the water that is used directly by individuals on site, and the indirect water footprint is the water that is used for the production of all the goods and services that are consumed (Water Footprint Network, 2017c).
So far, the water footprint approach has been applied to several big companies in the private sector such as Coca Cola and C&A. Also some organizations in the public sector have been working with this theory (Water Footprint Network, 2017b). However, it has hardly been applied to companies in the tourism sector, such as hotels. Therefore, this study tries to explore what the process of calculating a water footprint for a tourism business like a hotel looks like, and it will do that by applying the Water Footprint methodology.

The purpose of this research is to provide more insight into the process of calculating a water footprint for a tourism business such as a hotel. Water consumption in hotels is dependent on factors like the facilities that are provided by the hotel, and the age of those facilities, the amount of facilities and their efficiency. The behaviour of guests and staff also influences the direct water use in a hotel (Charara et al., 2011). Food production and waste dilution are two of those facilities which cause higher water consumption in hotels (Bohdanowicz & Martinac, 2007), and which in general also indirectly consume the most water in tourism (Yang et al., 2011). In a study by Yang et al. (2011) on tourist's water footprint in a mountain destination in China, it was

researched that on average, only 2,8% of the water that is used by tourists is used for direct purposes, 68,9% of the water is used indirectly for the production of food and the remaining 28,3% is water that is used to dilute wastewater (Yang et al., 2011). This shows that the indirect water footprint that is used for the production of food is the biggest share of the water footprint. Where the study by Yang et al. (2011) calculated the water footprint of tourists in that destination, this current study will focus on the water footprint of a business like a hotel. Since the indirect water footprint for food is proven to be such an important part of the water footprint, this study will focus on the food and beverages that are purchased by the hotel, in order to gain more insight in the indirect water footprint from the hotel side.

While the topic of water use in tourism is getting more under the attention, at the moment very little scientific literature exists about the contribution of tourism in water consumption. Even less scientific literature is to be found about water use within the production and consumption of food that relates to the tourism industry. Until now, most attention has been paid to the direct water use in the tourism sector, even though several authors have shown that most water is consumed indirectly (Gössling, 2015; Gössling et al., 2012; Cazcarro et al., 2014). Because this kind of research has been done very little before, calculating a water footprint of a hotel's food consumption can help to fill a research gap, and help to answer important questions that remain unanswered about this subject. To do this, research will be performed on one specific hotel to calculate its water footprint for food consumption. This will be a hotel that is located in the Netherlands, which has its own restaurant and therefore has to purchase food products. The scholarly relevance of this research is not the outcome of the water footprint of this specific hotel, but the methods with which the water footprint is calculated. Since this topic has not been researched before, it was likely that any difficulties would occur during the process of calculating a water footprint for a hotel's food consumption. The expectation is that difficulties will arise in trying to find the different production steps that were used for the food products that were bought by the hotel. With this research it is tried to address the difficulties that arise, and if possible it is intended to find a way to overcome such difficulties, in order to improve the process of calculating a water footprint for food consumption. In this way it can be used more often in the future, in issues such as water management, and therefore it can also contribute to the general practice of calculating a water footprint.

In order to do this research, the following main research question was asked:

RQ1: How can the methods for calculating a water footprint of a hotel's food consumption be improved for future usage in the tourism industry?

The following secondary research questions have been proposed to study the subject in more detail:

1.1 How does the water footprint of food consumption contribute to the total water footprint of hotels?
1.2 How can a water footprint for a hotel's food consumption be calculated?
1.3 What does the water footprint for W-Amsterdam's food consumption look like?
1.4 Which difficulties can be encountered during the process of calculating a water footprint for food for a hotel, and how can these difficulties be tackled?

2. Literature review

2.1 Water footprint

The total amount of water that is required to produce a certain good or service is measured with the so-called 'water footprint' (Hoekstra, 2008). The term water footprint is defined as follows by the Water Footprint Network: *"The water footprint is a measure of humanity's appropriation of fresh water in volumes of water consumed and/or polluted."* (Water Footprint Network, 2017c). It is a method that was inspired by the ecological footprint concept, and tries to delineate the human impact on water resources (Yang et al., 2011). One way of calculating a water footprint, is through the Water Footprint methodology that was first introduced by Hoekstra and Hung (2002). This is a method that can be used to quantify water use (Jeswani & Azapagic, 2011), and it can be used for calculating the water footprint of any individual, product, community, nation or business, as long as the proper consumption data are available (Yang et al., 2011). The water footprint of a particular product (either a good, commodity or a service) is the amount of water that is used to produce the product, but it is measured at the place where the product is actually produced. It takes into account the water that is used in each of the different steps of the production chain of the particular product (Hoekstra, 2008). It is important to measure the water footprint at the place where the product is produced, because within different areas or different countries there are big differences in water availability (Pfister & Bayer, 2014), due to climate, landscape and methods of irrigation that are used which have an effect on the amount of water that is used for the production of certain products. The time when a product is produced can also have a big effect on the amount of water that is used, because of the differences in water availability throughout different seasons (Hoekstra et al., 2012). This means that the water footprint is very much situated in time and space, since the area where a product is produced, and the time when a product is produced can have a big effect on the amount of water that is used for the production.

This water footprint method was developed as an analytical tool that is used to discuss policy issues related to water security and sustainable water use (Hoekstra, 2008). Furthermore, this methodology divides the footprint of water that is used directly, and the embedded water of all the products that are consumed. The latter is known as the indirect water footprint, or virtual water, and it refers to the water that is used to grow, produce, package and ship different commodities that relate to food (Hadjikakou et al., 2013). Therefore, it shows the different stages in the production and consumption of goods, which typically includes a farmer at the primary production end of the chain, a consumer at the consumption side of the chain and in between are some intermediaries such as retailers (Hoekstra, 2008).

The water footprint consists of three different components: the blue, green and grey water footprint. The blue water footprint is the amount of freshwater that is evaporated from global blue water resources such as surface and ground water, which is used to produce goods and services that are consumed. The green water footprint relates to the amount of water that is evaporated from green water resources, such as rainwater that is stored in the soil (Hoekstra, 2008). The green water footprint is not very relevant for human consumption, but it is however very relevant when it comes to the environment and agriculture (Yang et al., 2011). Then there is also the grey water footprint, which relates to the amount of polluted water, it measures the amount of water that is necessary to reduce any pollutants that exist in the water to such an extent that the quality of the water can live up to the agreed water quality standards (Hoekstra, 2008).

2.2 Water use in tourism

The growth of tourism that has taken place in the last decades can have significant economic benefits for destinations. However, it also brings along several negative impacts on the environment (Yang et al., 2011). One of those negative impacts is the impact that tourism has on the availability of water and the way it is used. Water use in tourism is becoming increasingly important on a global scale, since fresh water is a fundamental resource for tourism which is used in several different ways. Especially the water that is used directly, water that is used for food services and water that is used in waste dilution are very big consumers (Yang et al., 2011). For instance, houses and hotels which have gardens and swimming pools are examples which use especially high amounts of water because of the irrigation they need (Bohdanowicz & Martinac, 2007). If there is no pool or garden present then this means that the average water footprint of such a property is two to three times lower than when there is a garden or pool on site (Hof & Schmitt, 2011). In general, tourists tend to use more water when they are on a holiday than when they are at home. Since the majority of tourists stays in hotels, this makes hotels also big water consumers (Kasim et al., 2014; Gössling et al., 2012).

Even though there are several arguments to say that low density tourism is better for the environment than mass tourism, when it comes to water consumption this is not the case. More water is consumed per capita in low density tourist areas than it is in mass tourist areas, especially when it comes to water that is used outdoors such as in swimming pools and gardens with plants that are not from the local environment (Hof & Schmitt, 2011).

Making this water use sustainable has become an important challenge for the tourism industry (Gössling, 2015, Hadjikakou et al., 2013; Kent et al., 2002). Especially in dry areas in the world, knowledge about water use is very relevant to help prevent any water related problems such as water depletion and water pollution (Yang et al., 2011), and to come up with solutions for better water management (Cazcarro et al., 2014). What makes it even more important, is the fact that tourists tend to use more water on a per capita basis than the local inhabitants of a destination (Kent et al., 2002; Yang et al., 2011). This makes the direct impact of water use very concentrated in space and time, because of the seasonality that tourism deals with, which could lead to problems in areas that receive many tourists (Hadjikakou et al., 2013; Cazcarro et al., 2016). Since tourism numbers are still expected to grow globally, this water stress is also likely to increase (Hadjikakou et al., 2015). However, the impact that tourism has on water resources has been studied very little so far. This is due to the fact that when it comes to environmental sustainability, most attention has been paid to lowering carbon emissions (Hadjikakou et al., 2013). This lead to a lack of clear statistical documentation on water consumption in the tourism sector (Hof & Schmitt, 2011).

2.3 Research related to water use in tourism

The methods that are used to study the ways in which fresh water is used, are still developing. Most of the methods that currently exist focus mostly on the quantity of water that is used, and not so much on the social and environmental impacts that are related to this quantity of water use (Jeswani & Azapagic, 2011).

To this day, most research that has dealt with this subject has focussed mostly on direct water consumption in tourism. Often this takes into account only the water that is used at the accommodation. However, discussing only the direct water consumption that is produced on site does not provide the full picture of the total water use. According to Gössling (2015), Gössling et al. (2012) and Cazcarro et al. (2014), a lot of water is actually consumed indirectly, through the production of infrastructure, food, fuel, consumption goods and other services. It is this indirect

water use, which also forms part of the total water use that is included in tourism, that is still not sufficiently researched, and is therefore not well understood (Gössling et al., 2012).

2.4 Water consumption for the production of food

It is estimated that of the indirect water use, the production of food consumes the most, with a total of 87% of total water consumption (Gössling, 2015; Hadjikakou et al., 2013).

Of the entire water footprint that can be related to agriculture, approximately one-third can be accounted to the production of animal products such as meat, eggs, milk, etcetera. In the last three decades, the global meat production has almost doubled. This growing trend is expected to continue in the period 2000-2050. The reason why the production of animal products consumes so much water, is because of the animal feed that has to be grown. This is the part in the supply chain where most water is consumed, up to 98% of the total water footprint (Mekonnen & Hoekstra, 2012). Other parts of the water footprint consist of drinking water, service water and feed-mixing water. On the consumer side, people are often not aware of the processes of food production and therefore they have no knowledge about the water consumption that is related to animal products (Mekonnen & Hoekstra, 2012). Because the demand for animal products is growing, the demand for concentrate feed is also growing. Therefore, the blue and grey water footprints per unit of animal product will also increase. To limit this growth, policies would have to be implemented that manage the demand for animal products through a dietary shift which includes less meat (Mekonnen & Hoekstra, 2012).

When it comes to the production of crops, the water footprint that accounts for feed crops is 20% of the total crop production in the world. The water footprint of any animal product is always higher than the water footprint of a crop product with the same nutritional value (Mekonnen & Hoekstra, 2012).

Looking at tourism, especially for the hotel sector it is important to know more about the water footprint subject, since hotels are the most popular place to stay for tourists, and it is also the place where the most water is consumed (Tortella & Tirado, 2011). When focussing on the food consumption in tourism, it is better to focus on hotels than on restaurants. This is because hotels can be linked directly to tourism, and for restaurants this is not always the case. On top of that, hotels are seen as attractive targets when it comes to sustainable use of water, since they are observable and sensitive to public opinions (Gatt & Schranz, 2015). However, it should be said that tourists would also eat, had they stayed at home. This could be a reason why the water footprint for food consumption at a tourism destination is not seen as relevant to contribute to the water footprint. Nevertheless, depending on their type of holiday, tourists tend to have different behaviour patterns when they are on a holiday than when they are at home, which also has an effect on their consumption behaviour when it comes to food (Kasim et al., 2014). This could be a reason for tourists to consume more food when they are on a holiday than they would have, had they stayed at home.

Important questions that have to be asked, are about the quantity of water that is used in food production, and its whereabouts. Whether the water is used in the same region as where the products are consumed, or if it has been used to produce products elsewhere. This is important, because it reflects the water footprint of the entire supply chain of the tourist business, and adds to the virtual water trade of the country of production and consumption. Knowing more about this virtual water trade can be useful for countries which are dealing with water stress, since they can improve their food security by importing water-intensive food crops (Wichelns, 2004). When countries import products which require large amounts of water for their production

from countries which have water in abundance, water scarce countries can use their own water supplies for other purposes (Wichelns, 2010).
This type of knowledge remains very little represented in the literature so far, and will be interesting to find out in this study. The water footprint methodology that was introduced by Hoekstra and Hung (2002), has been used to calculate the water footprint of several agricultural products (Jeswani & Azapagic, 2011), but has never been applied to a tourism business before.

2.5 Sustainable water management for hotels

It is important for businesses to understand their role in water management, in order to make their own water supply sustainable. A factor which plays an important role in these environmental practices is the size of the business, since it influences the level of resource consumption, and the amount of externalities. The bigger the company, the higher the level of resource consumption, and the more externalities (Kasim et al., 2014). The water-neutral concept entails that individuals and companies are stimulated to make their activities 'water-neutral', by investing in technology to make their water use more sustainable. This could mean for example water saving technology, wastewater treatment and water conservation. The term means that any environmental or social consequences of a water footprint are reduced and compensated for (Hoekstra, 2008). It could also be interesting for businesses such as hotels to become water neutral, since it also decreases business risks such as the risk of having a shortage in water, or the fact that a hotel being water neutral can present itself in an attractive way to the consumers (Hoekstra, 2008).

3. Methods

3.1 Literature research

First of all, it is very important to understand what the concept of water footprint entails and how it is calculated. This information was gathered through an extensive literature research, in which several scientific articles were read and analysed to understand and clarify the subject matter. Since this study deals with the water footprint of food consumption for hotels, the focus of the literature research was also for a large part on the water footprint of food consumption. With this literature research it was tried to find out what the contribution of the water footprint of food consumption is on the total water footprint of hotels. Therefore, this method was used to answer sub question 1.1: How does the water footprint of food consumption contribute to the total water footprint of hotels? The literature was also used to learn and understand about how a water footprint is calculated. This information can answer sub question 1.2: How can a water footprint for a hotel's food consumption be calculated? It was important to distinguish in this case between the direct water footprint, and the indirect water footprint for food consumption. The information and knowledge that was gathered from the literature could then be applied in this research to the case study of calculating the water footprint for food consumption of the W-Amsterdam hotel.

3.2 Desk research

At the start of this research, the goal of this research was to calculate the water footprint for food consumption for a hotel, by following the water footprint manual by Hoekstra et al. (2012), since

this manual gives an extensive overview and explanation of how a water footprint of a supply chain can be calculated. By following this manual, the plan for this research was to perform interviews at different stages of the supply chain of the food that is served in the hotel. In this way it would be intended to find out the origin of each product, to find the specific water footprint that goes with each product, for the region where the product was produced. The first stage of the supply chain where interviews would be held, was the hotel itself. The person who is in charge of the food purchase at the hotel could specify where they get their products from, which would lead the researcher to the next step in the supply chain. It was expected that this next step would be a wholesaler where most of the products could be purchased. Therefore, the plan was to take interviews at the wholesaler as the next step in the supply chain, to find out where they got their products from. For some products it might also be possible to look at the label of many of the purchased products which can be found at the wholesaler to find out where they were made, and of which ingredients they consist. Then it would not be necessary to include these products in the interviews as well.

By researching the origins of all the different products that were purchased, it would be possible to compare different water footprint values for different regions to each other to see if there are significant differences. It would also be possible to see if the products that were purchased were produced in water scarce regions or in areas where a lot of water is available. If this information showed that some of the products that the hotel purchases were produced in areas that are water scarce, it would be possible to advice the hotel to take into consideration buying different products which are similar, but which are produced in different regions where water is less scarce. In this way, the impact that the hotel has indirectly on the environment could be diminished.

By finding out the origins of the products that were purchased, it would also be possible to take into account the water that is used during transportation of those products. This is important and should be included, since water is also needed for the production of energy, such as the production of fuel, the extraction of minerals, etc. It can take up to 18 litres of water to produce 1 litre of gasoline, which makes it quite water intensive (Gössling et al., 2012).

3.2.1 Contacting a hotel

In this study, a particular case for a hotel in The Netherlands was analysed to find out what their water footprint of food consumption looks like. This information could not be found in the existing literature, but had to be gained through different ways. Therefore, it was attempted to find a hotel that was willing to participate in this research.

To find a hotel that was suited for this type of research, and that was willing to participate in the research, information has been gathered on the internet about which type of hotels would be suited for this research, and emails were sent to various hotels. Hotels were selected which have their own restaurant with an à la carte menu. Because of limited time and budget, these hotels were all situated in the Netherlands.

On a first basis, hotels were selected which have a strong focus on sustainability. It was assumed that hotels with a strong focus on sustainability are also more interested to learn more about their water footprint for food, and therefore more eager to participate in this study. Emails were sent to 12 different hotels, situated in different regions of the Netherlands. Follow up calls were also made to 3 of these hotels. Unfortunately, this did not lead to a positive response from a hotel that wanted to participate in this study.

Eventually, contact was made with the international organization ‘Green Partner’. This is an organization which was founded by hotel managers, to help other hotel managers acquire internationally acknowledged certificates for sustainability. (Greenpartner, 2017) This

organization is currently working with the W-Amsterdam hotel, to investigate the hotel's current levels of sustainability when it comes to energy and water use.

W-Amsterdam is a five-star, luxury hotel which is based in the city centre of Amsterdam. It consists of 238 guest rooms, and two restaurants with à la carte menus. This hotel is interested in improving its level of sustainability, which is why it has asked Green Partner to make an overview of the current sustainability levels, to see where improvements can be made to acquire another sustainability certificate. The subject of the indirect water footprint that is focussed on in this study, could be combined with the research that Green Partner is currently performing on the hotel. It will complement the research about the water footprint of the hotel, since Green Partner is focussing mostly on the direct water that is used in the entire hotel, and this study focusses mainly on the indirect water that is used for the production of the food that is served in the hotel. A consultant who is working for Green Partner and who is performing this research on the hotel, has established contact through email with the purchaser of the W-Amsterdam hotel. Emails were sent to the purchaser as well, to acquire a list of all the products that the hotel purchases, and the quantities of these products. With this list, the water footprint for food can be calculated for this hotel. The purchaser of the hotel provided this list also through email, in excel format. Since a purchase list was provided through email, interviews did not take place with the purchaser, such as expected before starting the research, because they were not necessary anymore.

The desk research is a necessary method to be able to calculate the water footprint for the food consumption of hotel W-Amsterdam. It can therefore help to answer sub question 1.3: What does the water footprint for W-Amsterdam's food consumption look like?

3.2.2 Purchase list

The purchase list that was received from the purchaser of the W-Amsterdam hotel was a list of both food and non-food products. It does not only include a brief description of what kind of product was bought, but it also includes the quantity of the product that was bought, and the suppliers of the different products. Furthermore it also includes other information that was less relevant for this study, such as the article numbers of the products. Since this study only focusses on food products, the food products first had to be separated from the non-food products in the list, to calculate the water footprint of the food products. A total of 2535 food products were filtered from the original list and were put in a new excel sheet. On these products, the water footprint analysis could be performed.

3.3 Water footprint analysis

To calculate the water footprint, the existing Water Footprint Assessment Tool is used that was developed by the Water Footprint Network, in collaboration with the University of Twente. This tool provides information about how water is used for human needs, and what impact this water use has on different areas (Water Footprint Network, 2017a). It shows information about the water footprint as a whole, and it therefore includes the blue, green and grey water footprint.

This method will also contribute to finding out what the water footprint of the W-Amsterdam hotel's food consumption looks like, and therefore it also helps to answer sub question 1.3: What does the water footprint for W-Amsterdam's food consumption look like? With the use of this method, the focus will lie mostly on the indirect water footprint of W-Amsterdam's food consumption.

Since the purchase list consisted of a total of 2535 food products, this number was too big to perform a water footprint analysis on all those products. It would be too time consuming to do this, and in this research this was not possible, because of the limited time that was available. Therefore, two different methods of analysing the water footprint for the hotel through two different approaches were thought out and performed.

3.3.1 Method 1

For the first analysis, a selection of products was made from the 2535 food products that were filtered from the purchase list (method 1). This selection was made based on literature by Hoekstra (2008) and Mekonnen & Hoekstra (2010). The selection consisted of both animal products and crop products, and was formed with the products that use the most water per kilogram, and therefore have the highest water footprint per kilogram, according to the literature. The idea was to look at how much kilograms of these products with a high water footprint per kilogram were used by the hotel. The idea of this approach was that the products with the highest water footprint per kilogram which were bought by the hotel, would also have the highest impact on the total water footprint of the entire purchase list, and therefore also on the virtual water of the hotel. The products that were included in the selection were sugar, cheese, dates, (ground)nuts, olives, rice, butter, pulses, eggs and different types of meat (pork, beef, sheep/lamb, chicken, goose, turkey and duck). Table 1 and table 2 show how much water each of these products consume on an estimated global average. The water footprint of each product can vary significantly depending on the region where the product was produced, and which other ingredients were needed to produce the product (Hoekstra, 2008). For instance, meat of different animals has very different numbers when it comes to the water footprint. This can be explained because of the different types of feed that these animals need, and the different quantities of feed. For example, beef production needs 8 times more feed per kilogram than pig meat, and 11 times more than chicken meat (Mekonnen & Hoekstra, 2012). The data were used which show the amount of litres that were consumed per kilo of each product. Because of limited time to uncover the origins of each product, regional differences were not taken into account in this study. Therefore, the numbers were used which show the global average for each product.

Table 1. The water footprint of different food items.

Food item	Unit	Global average water footprint (litres)
Apple or pear	1 kg	700
Banana	1 kg	860
Beef	1 kg	15,500
Beer (from barley)	1 glass of 250 ml	75
Bread (from wheat)	1 kg	1,300
Cabbage	1 kg	200
Cheese	1 kg	5,000
Chicken	1 kg	3,900
Chocolate	1 kg	24,000
Coffee	1 cup of 125 ml	140
Cucumber or pumpkin	1 kg	240
Dates	1 kg	3,000
Groundnuts (in shell)	1 kg	3,100
Lettuce	1 kg	130
Maize	1 kg	900
Mango	1 kg	1,600
Milk	1 glass of 250 ml	250
Olives	1 kg	4,400
Orange	1 kg	460
Peach or nectarine	1 kg	1,200
Pork	1 kg	4,800
Potato	1 kg	250
Rice	1 kg	3,400
Sugar (from sugar cane)	1 kg	1,500
Tea	1 cup of 250 ml	30
Tomato	1 kg	180
Wine	1 glass of 125 ml	120

Source: Hoekstra, A.Y. (2008)

Table 2. The water footprint of some selected food products from crop and animal origin

	kilogram	kilocalorie	of protein	gram of fat
Sugar crops	197	0.69	0.0	0.0
Vegetables	322	1.34	26	154
Starchy roots	387	0.47	31	226
Fruits	962	2.09	180	348
Cereals	1644	0.51	21	112
Oil crops	2364	0.81	16	11
Pulses	4055	1.19	19	180
Nuts	9063	3.63	139	47
Milk	1020	1.82	31	33
Eggs	3265	2.29	29	33
Chicken meat	4325	3.00	34	43
Butter	5553	0.72	0.0	6.4
Pig meat	5988	2.15	57	23
Sheep/goat meat	8763	4.25	63	54
Bovine meat	15415	10.19	112	153

Source: Mekonnen and Hoekstra (2010)

3.3.2 Method 2

Another method to calculate the water footprint, was determining which food products were purchased the most (method 2). In the list of 2535 food products, a new selection was made of all the products that were purchased 100 times or more. This selection did not focus only on the products that already consume the most water per kilogram according to the literature, but took into account all the food products in the list. The assumption of this method was that the products that were purchased the most, are also the products with the most weight in total. Therefore, this method does not look at the products with the highest water footprint per kilogram, like method 1 does, but it looks at the products with the most kilograms, and tries to find the water footprint that goes with that.

After calculating the water footprint of the hotel by using these two methods, the results can be compared to see if there are any differences or similarities, and if there are any positive and negative aspects of calculating in this way. If big similarities can be seen in the results of the two methods, then this means that the two methods combined make a good representation of the water footprint of the complete list of food products that were purchased by the hotel. Therefore, methodologically speaking this would be ideal, since this can say something about using (a combination of) these methods for future research on the water footprint of food for a hotel. If big differences can be seen in the results of these two methods, then this means that the two methods do not represent the total water footprint of the complete list of food products well enough. However, if for example the total water footprint for method 2 results to be lower than the total water footprint for method 1, then this means that the products which are purchased the most, are products which consume less water per kilogram. This would be beneficial for the environment.

3.4 Ethnographic research

Ethnographic fieldwork was performed during this research, because some of the data had to be produced from the researcher's own experiences, and decisions that had to be made in the process. Every step that was taken in the case study of calculating the water footprint of hotel W-Amsterdam's food consumption had to be described in detail by the researcher. Especially the difficulties that arose while doing the research are a very important outcome of the ethnographic research. This research method can answer sub question 1.4: Which difficulties can be encountered during the process of calculating a water footprint for food for a hotel? The difficulties will be addressed and explained, but in addition to that it will also be attempted to find a way to overcome these difficulties, and translate these findings in recommendations for future usage and future studies.

4. Results and analysis

4.1 The contribution of the water footprint of food consumption to the total water footprint of hotels

The contribution of the water footprint of food consumption to the total water footprint of hotels was researched with the existing literature on the subject of water footprint in tourism. In previous research, when it comes to the water footprint of hotels, most attention has been paid to the direct water footprint which is consumed mostly in accommodation (Gössling, 2015).

Water is used directly in hotels for several different purposes, such as washing or using the toilet, activities such as a golf course, spa facilities such as wellness areas and swimming pools, but also for the landscaping of a hotel like for instance to water the gardens (Gössling et al., 2012; Gössling, 2015). As average hotel standards are rising globally, the water use in hotels is also growing. There is a significant difference in water use between luxury hotels and average hotels. Five star hotels use more water (594 litres per overnight stay) than average hotels (394 litres per overnight stay). This is due to the extra facilities that are present at luxury hotels which cost a lot of extra water (Tortella & Tirado, 2011).

Not only the direct water use, but also the indirect need for water is growing, in part because of higher-order foods (Gössling et al., 2012), which are popular especially in tourism (Gössling, 2015).

Looking at the direct water footprint of food, it is researched by Gössling (2001), that restaurants in guesthouses make up for 15% of all the water that is used in guesthouses, and 5% of the water that is used in hotels. According to a different study by Smith et al. (2009), restaurants in hotels use up to 16% of the total water use. Even though the direct water use in hotels is higher than the water that is used directly for food, the amount of embodied water for food is much bigger because of all the different supply chains that are involved in the production of the food (Cazcarro et al., 2014)

According to Gössling et al. (2012), Gössling (2015) and Cazcarro et al. (2014), indirect water use is more relevant than direct water use, since it is much bigger than the direct water use (Hadjikakou et al, 2013). From this indirect water use, especially food consumption and fuel use stand out, because they have a greater share of water that is used for consumption (Cazcarro et al., 2014; Yang et al., 2011). These are the two categories that on average use the most litres of water per tourist per day. To compare it, accommodation is estimated to use between 84 and 2000 litres per tourist per day, and food can use between 2000 and 5000 litres per tourist per day (Gössling et al., 2012). In figure 1 can be seen that the estimates of the amount of water that is used vary greatly. It is however very clear how big the contribution of food is to the total water use. Gössling (2015) states that food accounts for an estimated 87% of the total water consumption in tourism, which makes it the biggest water use component.

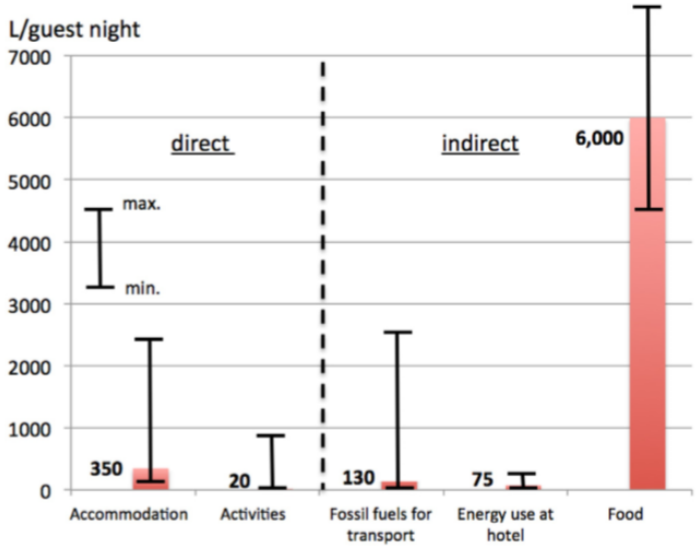

Fig. 1. Globally averaged water footprint, L per guest night (Gössling, 2015)

Gössling (2015) also shows that of the food that is consumed in restaurants of hotels, the amount of high protein foods is high. In his study, tourists consumed on average 0,385 kg of meat per person per day, 0,294 kg of dairy products and eggs per person per day, and 0,139 kg of seafood and fish per person per day. Meat and dairy products have a high water footprint compared to their weight, since they consume a lot of water in the supply chain. In that sense, the water footprint of fruit and vegetables is less significant compared to their weight (Gössling, 2015).

Nevertheless, there is still a lot that remains unknown about the water that is used through food consumption at a tourism destination, compared to the water that is used for food consumption at home, and what the contribution is of higher-order food at tourism destinations (Gössling et al., 2012).

4.2 Calculation of a water footprint for a hotel's food consumption

This study uses the Water Footprint assessment methodology as developed by Hoekstra (2003), to answer the second sub question on how a water footprint for a hotel's food consumption can be calculated. This methodology is explained in the water footprint assessment manual by Hoekstra et al. (2012). In the ideal case of calculating a water footprint for the food consumption of a hotel, two ways of water footprint accounting are of importance. The first method that is relevant is the 'water footprint of a product', since the water footprint that is calculated for the hotel, is calculated for each food product that is on the purchasing list. The water footprint of a product refers to the total volume of fresh water that is used directly or indirectly to produce the product (Hoekstra et al., 2012). It includes the green, blue and grey water footprint, and it therefore takes into account the water consumption and also the pollution in each step of the supply chain where the product is produced. It can also be referred to as the 'virtual-water content'. In order to calculate the water footprint of a product, it is important to know and understand the way in which a product was produced. This production system should then be laid out in several different process steps, which show the origins of the different inputs of the product and where they were added. To calculate the water footprint of the final product, the water footprint of each intermediate process step should be calculated (Hoekstra et al., 2012).
Another way of water footprint accounting that can be relevant to calculate the water footprint for food for a hotel is the 'water footprint of a business'. This refers to the amount of fresh water that is consumed or polluted by the business itself, meaning all the goods and services that are produced by the business which need the input of fresh water. The business water footprint consists of an operational water footprint and a supply chain water footprint. The operational water footprint includes the water footprint that is directly associated with the production of the business's products on site, and the supply chain water footprint includes the water footprint of products associated to the business, which are purchased by the company to process their product. So the operational water footprint refers to directly used water, and the supply chain water footprint refers to water that is used indirectly. This difference is not so clearly distinguished in the product water footprint (Hoekstra et al., 2012).
The total water footprint is calculated by adding the calculated operational water footprint, and the supply chain water footprint.

The Water Footprint methodology by Hoekstra and Hung (2002) has not been applied before to tourism businesses such as hotels. It focusses both on direct water that is used for drinking, washing and cooking, and on indirect water used in the supply chain of the products that are consumed. This is known as Virtual Water, which consists of the amount of water that is used in

the supply chain of the product to grow, produce, package and ship the products. Large amounts of virtual water are consumed through the diet of tourists (Hadjikakou et al., 2013). The reason why it is called Virtual Water is because the amount of water that is still inside the actual product is much smaller than the water that was used during the production (Chapagain & Orr, 2009).

The water use in hotels that has been investigated in previous research is usually calculated as 'water use per guest night' or 'water use per tourist per day', which has the same meaning. To calculate a water footprint for a hotel's food consumption, data on food use is required from the hotel, for example in the form of a purchase list for a certain year (Gössling, 2015), as is used in this study. For a relevant selection of food items, the total weight of each item has to be determined. Apart from the weight, it is ideally also important to examine the origin of each product, and its exact composition of different ingredients. For each product and for each individual ingredient, the water footprint should then be calculated to get a complete and detailed picture of the total water footprint for the hotel's food consumption. The values of these food products are provided by Mekonnen & Hoekstra (2010a, 2010b). These are numbers that are expressed in m^3 per ton, which equals litres per kilogram, and they include the green, blue and grey water values for both animal and crop products. It also shows specific numbers for each of these products per country and per region, taking into account local climate conditions, production efficiencies and origin of imports (Hadjikakou et al., 2013). In this way, the exact water footprint values can be used for the specific region where the products were produced. The water values of each product are then added up by taking the sum of the water values for the green, blue and grey water footprint.

The results of this water footprint analysis do not only include the food that is actually consumed by the tourists, but also includes food that is wasted, for example while preparing it in the kitchen or for any other reason (Gössling, 2015).

4.2.1 Calculating the water footprint for the W-Amsterdam hotel

In the purchase list, the quantities were registered of how many times a specific item was bought. This did however not always include the weight of the products. Therefore, the weight of the products was first calculated by looking up many of the products on the website of the suppliers. This provided more information about how the product was packaged, specific ingredients of the product and in most cases also the weight of the product. The number of times the product was bought was then multiplied with the weight of the product, to get the total weight of each product. The weight was calculated in kilograms for each product. Once this was calculated for each product, the data from Mekonnen & Hoekstra (2010a, 2010b) were used to calculate the water footprint of each product separately by multiplying the weight of the products with the water footprint data from the literature.

The water footprint for the W-Amsterdam hotel was then calculated according to method 1 and method 2 that were explained previously in the methods section.

4.2.1.1. Method 1

The first method that was performed was by calculating the water footprint of the selection of products with a water footprint that is already known to be high per kilogram. Of the 2535 different food products that were filtered from the original purchase list, a total of 401 products were selected to perform the water footprint analysis on. Of those products, the different kinds of meat products represented the smaller part, of in total 171 products. To be more specific, 51 of the products were pork meat, 39 were chicken meat, 55 were bovine meat, 12 were sheep or

lamb meat, 1 was goose meat, 8 were turkey meat and 5 were duck meat. The majority of the 401 products were other products from animal origin, or crop products, with a total of 230 products. To be more specific, 28 of the products were (ground)nuts, 31 of the products were olives or olive oil, 14 of the products were sugar, 37 of the products were pulses, 15 products were rice, 7 products were butter, 17 products were eggs, and 81 of the products were cheese.

4.2.1.2. Method 2

The second way that was used to calculate the water footprint for the W-Amsterdam hotel was by measuring the water footprint of the products that were purchased the most, and were therefore expected to have the highest weight in total. To do this, another excel sheet was created and a new selection was made from the 2535 food products, to filter out all the food products that were bought a 100 times or more, to see if these were also the products which actually had the most weight in kilograms. This resulted in a list of 167 different products, consisting of both food and beverages.

4.3 The water footprint for W-Amsterdam's food consumption

4.3.1. Method 1

The water footprint values of all the purchased products that were calculated according to method 1 are displayed in table 3. The table is ordered in such a way that the product with the highest water footprint value is on top, and the product with the lowest water footprint value is at the bottom. This table includes the products that were selected, including the amount of products that relate to each product category, and the weight of each product category in kilograms. It also includes the total numbers of the green, blue and grey water footprint for each product. This was then added up to show the total water footprint for each product, and the total water footprint for the W-Amsterdam hotel according to this method.

The total water footprint for method 1 is a rounded 136,7 million litres per kilogram. This means that for the W-Amsterdam hotel, the water footprint would be 1.574 litres per room-night.

It can be seen in the table that the water footprint for bovine meat stands out, in that it is by far the biggest number in the list. This is not surprising, since in the literature is also said that bovine meat has the highest water footprint compared to other products from both animal and crop origin (Hoekstra, 2008). What is interesting to see is that the total water footprint for chicken meat is about 3 times higher than the total water footprint for pig meat, even though the quantity of chicken products that were bought is lower than the quantity of pig products. This can be explained by the weight of the products that were bought. The chicken products were bought in much higher quantities than the pig products, and therefore they had much more weight. The same goes for turkey meat, which consists of only 8 different products, but was bought in very high quantities which caused a lot of weight.

Another number that stands out in this table is the total water footprint of olives and olive oil. Even though this is a product from crop origin, it is still a product with a high water footprint per kilo (Hoekstra, 2008).

Table 3. The water footprint values of a selection of purchased products in litres

Product	Quantity	Weight in kilograms	Green water footprint	Blue water footprint	Grey water footprint	Total water footprint
Bovine meat	55	3.617,57	54.194.252,24	2.060.658,57	1.695.522,13	57.950.432,94
Chicken meat	39	5.381,32	18.943.845,3	1.683.965,26	2.512.371,6	23.140.182,14
Olives & olive oil	31	1.292,98	9.359.415,25	1.889.827,53	171.283,88	11.420.526,65
Cheese	81	2.214,27	8.505.128,56	876.865,87	723.406,48	10.105.400,9
Pig meat	51	1.672,76	8.083.114,09	762.861,39	1.025.098,05	9.871.073,53
Eggs	17	1.326,16	3.429.459,18	324.094,44	567.379,04	4.320.932,66
Nuts	28	559,69	2.675.157,96	481.816,33	309.920,66	3.466.894,95
Pulses	37	1.507,45	2.532.460,68	207.153,79	670.959,55	3.410.574,02
Rice	15	1.439	2.312.862	681.643	376.336	3.370.841
Butter	7	569	2.671.455	264.585	223.617	3.159.657
Turkey meat	8	540,53	1.916.164,67	169.184,64	252.425,64	2.337.774,95
Sugar	14	1.453,9	1.721.417,6	448.478,3	161.382,9	2.331.278,8
Sheep/lamb meat	12	302,8	1.516.419,4	76.911,05	11.809,18	1.605.139,62
Duck meat	5	45,27	160.482,15	14.169,51	21.141,09	195.792,75
Goose meat	1	5	17.725	1.565	2.335	21.625
Total	401	21.927,7	118.039.359,08	9.943.779,68	8.724.988,2	136.708.126,91

4.3.2. Method 2

In table 4 it can be seen that in the method which calculated the water footprint for the products that were purchased the most (a 100 times or more), a total of 167 different products were included in the selection. The water footprint was calculated for each individual product, and was then added up to find the total water footprint for the hotel, according to this method. The selection consisted of many different products which were not separated in different categories. For this reason, only the total water footprint values of the entire selection are displayed in table 4. In this table it can be seen that the 167 products that were included in the selection, all together weighed about 86.450 kilograms, and the total water footprint for this method was a rounded 135,7 litres per kilogram. For the W-Amsterdam hotel, this would be 1.562,1 litres per room-night.

Table 4. The water footprint values of the most purchased products in litres per kg

Quantity of products	Weight in kilograms	Green water footprint	Blue water footprint	Grey water footprint	Total water footprint
167	86.451,4	115.829.578	10.533.887,3	9.349.175,79	135.712.641,09

When the results of the two methods that are displayed in table 3 and table 4 are compared to each other, it can be seen that in table 4, a lot less products are included in the selection, but the total weight in kilograms is over 4 times higher than the weight of the selection that is shown in table 3. It can also be seen that the total water footprint of the two methods that is shown in table 3 and table 4 is quite similar, as well as the number of litres per room-night. This would suggest that the two methods complement each other quite well in calculating the total water footprint for the W-Amsterdam hotel, and that they could be combined to get a better picture of the total water footprint for the hotel.

4.4 Difficulties encountered during the calculation process, and how they can be tackled

4.4.1. Assumptions and simplifications in the calculation process

Unfortunately, the ideal way of calculating a water footprint for the W-Amsterdam hotel which was described before, could not always be realized in this study. Some assumptions and simplifications had to be made because of the nature of this research, and because of some issues that were encountered.

In the ideal calculation of a water footprint, the origin of all the products and the exact composition of different ingredients would be taken into account to get a complete picture of the total water footprint for each product per region, and for the total water footprint of the hotel's food consumption. By uncovering the origin of each product, the water footprint of the transportation of the products could also be taken into account. Unfortunately, in this study it was not possible to determine the origins of the products that were purchased, because determining the origins of each product would take a lot of time, which was not available in this research. The only information that was available in this study, was the purchase list that was provided by the hotel, and the information that could be found on the websites of the suppliers of the products. For the majority of products, the origin could not be determined with this information that was available. Therefore it was decided to use the water footprint values which represent the global average for each product. The transportation that was needed to get the products from their country of origin to the W-Amsterdam hotel could therefore also not be taken into account.

The same goes for the composition of different ingredients for each product. To find out the exact composition of ingredients for each purchased product, information should be available to know what those exact ingredients are and in which quantities. For some products it was possible to gain this information, and for other products it was not. However, since it would be very time consuming to uncover the detailed composition of each product and then calculate the water footprint for each individual ingredient, it was decided to assume that the products consist for 100% of the same ingredient. Unless it was clearly specified in the description of the product, then only the percentage of the product that was researched was calculated. For

example, while calculating the water footprint for eggs, one of the products was an egg salad which apart from egg also consisted of other ingredients. In this case, only 67% of the weight of the product was calculated, because this number represented the added egg in the product. It was decided to do this in this way, since the egg is the specific ingredient which was included in the selection to be calculated.

Also, while for the majority of products there was a detailed description in the appendices of the reports by Mekonnen and Hoekstra (2010a, 2010b), which could be matched with the products in the purchase list to calculate their water footprint, for some products there was no exact description which could be used. However, there were some water footprint values in the list which represented products 'Not Elsewhere Specified' (NES). These values existed for all different products such as for all the different types of meat, pulses, nuts, fruits, etc. For example a prepared product such as a hotdog or prosciutto ham which are known to consist of pork meat were not specified in detail in the reports. Therefore, for products such as these, the values for 'pork meat NES' were used to calculate a water footprint value.

The water footprint values for chicken were not represented in the appendix of the report by Mekonnen and Hoekstra (2010b) for animal products, where the other water footprint values were taken from. However, in the actual report of Mekonnen and Hoekstra (2010b), a water footprint value for chicken was presented, though this value was not as detailed as the water values for the different types of pork or bovine meat, since it was only 1 general value for chicken meat which was not further specified in different types of chicken meat. Since this was the only water footprint value that was available for chicken, this value was used for all the different chicken products that were included in the selection from the purchase list.

There were also some products which did have to be excluded from this study and which could not be included in the selection. From the selection in method 1, chocolate had to be excluded. Even though it is known from the literature (Hoekstra, 2008) that chocolate has a high water footprint per kilogram, and there were a number of products in the purchasing list which represented chocolate, for most of the chocolate products it was not possible to determine their weight. This was because many of the chocolate products that were bought by the hotel were not standard chocolate bars, but specially made chocolates such as pralines or luxurious delicacies such as for example a chocolate scrabble set. The supplier of these products did not specify any detailed information on these products, such as their weight. Since this was the case for the majority of chocolate products, it was decided to exclude them from the selection.

In method 2 there were also some products that were excluded from the selection. One product category that had to be excluded was spirits. There were no water footprint data available on the spirits that were in the purchase list, and since spirits are made of many different ingredients, it became too complicated and too time consuming to calculate the water footprint for each type of spirits separately. For this reason it was also decided to exclude the category of spirits from the list in method 2. A total of 20 different spirits were therefore excluded. Another product that was excluded in method 2 was fish. There were very few fish products represented in the selection of method 2, and there was no water footprint data available on these fish items. Therefore, the fish products were also excluded, but because of their limited number it was believed that they would not have made a significant contribution to the total water footprint.

In the selection that was made in method 2, there were also several soft drinks that were included. Soft drinks can also consist of different ingredients, but since the soft drinks all contain sugar which is an ingredient which is known to consume a lot of water per kilogram (Hoekstra, 2008), it was decided to calculate the weight of the sugar for these soft drinks and include this number in the calculation. It was assumed that soft drinks consist for 10% of sugar, 25 grams per 250 ml (KRNWTR, 2017).

Method 2 was calculated based on the assumption that the products that were purchased the most would also have the most weight. For the majority of the products in the selection this was also the case, but not for all of those products. One of those products was for example parsley, which was bought 244 times, but because of its small weight, the total weight for parsley was only 6 kilograms. Therefore, the assumption that the products that are purchased the most will also weigh the most is not always correct. However, most products in the selection did live up to the assumption that they were the products with the highest amount of kilograms, since only 30 products weighed under 50 kilograms, of which the majority were products in the category of fruits and vegetables and are therefore products with a low water footprint per kilogram.

4.4.2. Unknown relevance for hotels

During the preparation phase of this research, an issue was uncovered that should be dealt with in the future. The issue was that it was very difficult to find a hotel that was willing to participate in this research. Currently, hotels are mostly interested in learning more about their direct water footprint, in order to become more sustainable in their water and energy use (Gatt & Schranz, 2015). In this way the hotels can actively change their policies or their equipment to save more water or energy. This is beneficial for the hotels because in this way they can also save on their energy costs. Since a hotel is a commercial business which depends very much on their gains and expenses, the possibility of saving money on energy costs is very interesting to them as long as it doesn't affect the guest comfort and satisfaction (Charara et al., 2011). The indirect water footprint is lesser known for businesses, including hotels. Since it does not involve water that is used directly in the hotel itself, the hotels tend to think that the indirect water footprint is not relevant to them. There are no direct costs that can be decreased for the hotel. Because of this, and because of the fact that businesses are often not aware of the indirect water footprint, they also seem to be less interested in this topic. If the relevance of the water footprint for hotels can be made clear so that hotels become more aware of the topic and what it entails, it could be that hotels become more interested in learning more about the topic and having it researched more. It could be beneficial for hotels to know about their indirect water footprint to get an insight into their exact water use and possibilities to save water. Performing such an indirect water footprint analysis in a hotel could lead to innovation, since it is still very new. By gaining insight in the indirect water footprint and possibilities to save water, it could also improve the sustainability of the hotel if water is actually saved where possible. Improving the sustainability of the hotel is also good for marketing purposes, because it could improve the overall image of the hotel as being sustainable and aware of the environment (Kasim et al., 2014). Insight in the water footprint can support the hotel on achieving sustainable water management, not only in their direct operations through the direct water footprint, but also within their supply chain through the indirect water footprint (Water Footprint Network, 2017d).

An option to bring the indirect water footprint more under the attention would be for example to include it in the requirements that are needed if the hotel wants to acquire a certain sustainability certificate for hotels.

Another challenge for this research that has to do with the hotels, is the fact that hotels are not very eager to share their purchase data with independent researchers. It was found out in the preparation phase while emailing the various hotels, that a purchase list is considered as competitive data, which was a reason why it could not be distributed, even with a guarantee of confidentiality.

4.4.3. Lack of information and data

Since the water footprint for food in hotels has not been researched in the past, there was not a lot of literature that could explain the topic in detail. Therefore, there was no pre-established way of performing a water footprint analysis for food for a hotel that could be followed in this research. The reports that were used by Mekonnen & Hoekstra (2010a, 2010b) based their data on studies that were realized between 1996 and 2005, for all the products from animal origin and crop origin. Because of recent developments regarding climate change, it is possible that those data have changed in the meantime. For instance, it could be possible that more water was needed to produce a certain product, or that less water was needed to produce a product, depending on the area where the product is produced. Steps in between the supply chain could also change because of certain developments or innovations. Furthermore, these data are quite limited to use for a research focussing on the entire water footprint of food for a hotel, because there are several products which are not included in the list. This could be different types of processed foods which are more difficult to specify under a certain category, but there was also a lack of data for example for the different types of nuts. Only the nuts that are most common were represented with data in the list, and the nuts that were not specified in the list were listed generally as "nuts Not Elsewhere Specified (nes)".

Therefore, to overcome this issue, a more detailed list of products would be needed to perform future research in water footprints for food. If such a list could be made available online, it would be possible to keep it up to date if any changes were to occur. It would then also be possible to specify in which part of the supply chain the water was used, since this data is currently not available.

5. Discussion

In this study, it was researched what the importance is of the water footprint for food consumption in a hotel, and a water footprint analysis was applied to the case of the W-Amsterdam hotel in The Netherlands. When it comes to the topic of the water footprint, there is still a big gap in the literature which this study has tried to fill a little bit more. It was found out that the direct water use of hotels is relatively well known, and that hotels are often actively trying to reduce their direct water use. A reason for this is that it is cost-related, which is very important to a business like a hotel which is very much focussed on profit. What is however not directly cost-related to the hotel, is the indirect water that is used in the production of the food that is served in the hotel's restaurant. This is probably the reason why hotels have not been actively engaged in this subject so far, though this study does not provide the arguments to prove this.

The water footprint methodology that was introduced by Hoekstra and Hung (2002) was used in this study to better understand the concept of indirect water footprint and to apply it to the case of the W-Amsterdam hotel. To calculate the water footprint of the different food products that were purchased by the hotel, literature by Mekonnen & Hoekstra (2010a, 2010b) was used.

Two different methods were used to calculate the water footprint for the W-Amsterdam hotel's food consumption. The first method that was used, calculated the water footprint values of products which are known to have a high water footprint per kilogram, according to the literature by Hoekstra (2008) and Mekonnen & Hoekstra (2010). The outcomes of this method provide information on which of those categories have consumed the most water in the case of the W-Amsterdam hotel. With this information, recommendations could be made to the hotel to find alternative products for some of the items that consume the most water. In this case, their indirect water footprint for food could be lowered. It is however true that a hotel can never

become fully water neutral, both in their direct and their indirect water use. This is because some of its services will always require the use of water. Think of services like laundry, water use in the kitchen and the water that is used to produce the products that are used in the restaurant of the hotel. The important aspect is therefore not to limit water use to zero, but to save as much water as possible and to offset any negative impacts that water use may have on the social and natural environment (Hoekstra, 2008). Therefore, this also includes the indirect water use since this could also have negative impacts on the environment.

The second method that was used to calculate the water footprint for the W-Amsterdam hotel's food consumption was by calculating the water footprint values for the products that were purchased the most, with products that were bought a 100 times or more, and which were therefore assumed to have the highest amount of kilograms. With this method it is harder to make recommendations to the hotel about their indirect water footprint, since it is more difficult to compare the outcomes for the different product categories with each other. This list is simply focussed on products that are bought the most, with the highest kilograms, and therefore it excludes other products which may also consume big amounts of water. It does give an overall picture of the water footprint for food for the hotel, but less detailed than the overall picture that is given by method 1.

By comparing the results of the two methods, it can be decided whether or not these methods are suitable to be used again in the future, and whether or not they complement each other. In this research it was found that the results of the two methods were rather similar, since there was no big difference in the total water footprint that came out the two methods. This means that the two methods actually do complement each other, and that the selection that was made presents a good representation of the overall purchase list of the hotel.

5.1 Limitations

The water footprint method that was developed by Hoekstra is a tool that can help to show in which ways the world's freshwater resources are used and by whom they are used. This is important because of the limited freshwater resources that are available on this planet. It can be used to determine whether footprints are sustainable or not, and to find possibilities to reduce water footprints if necessary. However, using only the water footprint methodology is not enough to determine sustainable use of natural resources. This methodology would have to be complemented with other methods and other aspects to get a complete image of sustainable use of resources, and in order to understand it completely to be able to make well-informed decisions to improve this sustainability. Furthermore, the water footprint methodology focusses only on water issues that are related to water scarcity, and does not pay attention to other water issues such as flooding, or lack of infrastructure for water supply (Hoekstra et al., 2012). It also doesn't take environmental issues into account, such as climate change, soil degradation or depletion of minerals (Hoekstra et al., 2012; Jeswani & Azapagic, 2011). This can lead to concerns about the possibility that this approach could provide misleading results. It is also argued by Jeswani & Azapagic (2011), that the analysis of water use is controversial because it includes data on green water, while this does not affect the availability of blue water. These authors say that for this reason, green water as in rainwater such as moistures in soils should not be included (Jeswani & Azapagic, 2011).

The water footprint concept has not been applied a lot yet to businesses, which means that there is very limited experience with the concept in practice. Because of this, there is a lack of information and no previous examples where full water footprint assessments are performed (Hoekstra et al., 2012).

Companies often tend to focus only on the profit that they are making, and any sustainability assessments that are realized usually take the three P's 'people, planet, profit' into account. Lately, companies are becoming more interested in their 'water risk'. Part of this risk can be

understood by analysing the water footprint of a company, because it shows which parts of the company's water footprint are not sustainable. However, a water footprint analysis is not enough to determine the water risk of a company. In order to determine this, a full risk assessment is necessary (Hoekstra et al., 2012).
The question still remains whether the water footprint of food consumption really adds something to the total water footprint in tourism, because of the fact that tourists also have to eat if they stay at home. Since this study had a supply side perspective looking at the products that are supplied to tourists by the hotel, it is believed that this study does add to the literature on water footprint in tourism, since a hotel is a tourism business. More research would be needed to see how the food patterns differ between people when they stay at home and when they go on a holiday, and then calculate the water footprint for these different situations to see how much the food consumption in tourism differs from the food consumption when people stay at home. This could give more insight on the demand side of the water footprint for food consumption in tourism.

5.2 Assumptions and simplifications

In this research, several assumptions and simplifications had to be made because of several different reasons, but mostly because of a lack of time and a lack of available information. An important simplification that was made was to use the water footprint data of the weighted global averages which were provided by Mekonnen and Hoekstra (2010a, 2010b), instead of the detailed water footprint values per region of production. This caused the results of this research to be well suited to raise awareness, or to identify the products which contribute most significantly to the total water footprint (Hoekstra et al., 2012). However, the data still remains rather superficial, because due to limited time, the research has not gone into detail on the space-time differences which occur in the water footprint between different regions of production.
Not only because of the global average water footprint data that were used, but also because of the other assumptions and simplifications that were made, the final water footprint for the W-Amsterdam hotel that was calculated remains rather superficial. To make the water footprint analysis for the hotel more detailed, the exact ingredients of the products should be studied to calculate the exact water footprint for the composed product, and the origins of the products should be determined to take the space-time aspects of the water footprint into account. By knowing where the products come from, the water that is used for the transportation of the products can also be added to the total water footprint.
Only one water footprint value was used for chicken meat in this study, because detailed water footprint values for different types of chicken products were not available. While this may not give a perfect reflection of the water footprint of the chicken meat that was purchased, it was decided that it was better to use this value than to exclude chicken completely from the selection. However, it was regrettable that chocolate had to be excluded from this study because the weight of the chocolate products could not be determined. Chocolate is a product which is known to have a high water footprint per kilogram (Hoekstra, 2008), and the purchase list consisted of several chocolate products. If the water footprint for the chocolate products could have been calculated, it could possibly have a significant effect on the total water footprint for method 1. While the results of this study show a similarity in the results between method 1 and method 2, the possibility exists that the results of the two methods would not have been so similar if the water footprint for the chocolate products could have been included as well.

5.3 Validity

The fact that the water footprint methodology has not been put to a lot of practice in businesses, and especially in tourism businesses, might affect the internal validity of this study. It has not been proven that the way in which this study was performed can lead to valid results. However, in order to find out whether or not this method can be proven useful, there have to be some

studies that put it to practice first. This study has made an attempt to do so, based on the information that was available.
This study was performed on a single hotel, the W-Amsterdam hotel that is based in Amsterdam, The Netherlands. Since the focus of this study lies mostly on analysing the water footprint methodology for calculating the water footprint of a hotel's food consumption, and less on the outcome of the water footprint analysis for the specific hotel, it was enough to apply this analysis to the case of only one hotel. However, this does not mean that the outcomes for the W-Amsterdam hotel can be generalised for other hotels which are similar. When hotels want to know about their indirect water footprint for food consumption, they would still have to do their own individual analysis. Also, when it comes to the indirect water footprint of food consumption in general, it is not possible to base conclusions on the case study of one hotel which is situated in a water rich country such as The Netherlands. The only conclusions that can be made are conclusions to improve the water footprint methodology to calculate a hotel's water footprint for food consumption.

5.4 Future research

For future research, it would be recommended that more attention is paid to the concept of the indirect water footprint, not only in academic research and literature, but also in practice, so that hotels and other businesses become more aware of the concept. The methods that were used in this study to calculate the water footprint for a hotel's food consumption were a good first try, but in the future they can still be improved a lot in order to get a complete picture of the water footprint for the hotel's food consumption. The assumptions and simplifications that had to be made in this study should be diminished as much as possible in the future. In this way, the results of the water footprint analysis become less superficial and more detailed, taking also the space-time aspects of the water footprint into account. In this way it will be possible to get an idea of what the water footprint of the hotel's supply chain for food exactly looks like.
Furthermore, at this moment, the relevance of the indirect water footprint concept is often either not known to hotels, or the concept does not strike them as important. Which of the two is generally the case should also be looked into further in the future, in order to be able to reduce the indirect water footprint for these tourism businesses. The concept could also be incorporated in sustainability labels that can be awarded to hotels. In that way there is a higher probability that hotels are interested in learning about the concept, since many hotels are eager to get a sustainability label for marketing purposes (GreenPartner, 2017).
The lack of information and data that was experienced as problematic in this study should also be a topic for further research. There is still a very big gap in the literature when it comes to the water footprint in tourism, and especially when it comes to the indirect water footprint that is related for example to food. More research is needed to better understand what the indirect water footprint for various tourism businesses in different tourist areas looks like.
In order to do this, more water footprint data on different food products is also needed. The water footprint values that were provided by Mekonnen and Hoekstra (2010a, 2010b) were helpful for this first try at calculating a water footprint for food consumption, but they were not complete, which caused some of the limitations.

6. Conclusion

This study has attempted to fill a gap in the literature by providing more insight into the indirect water footprint of a hotel's food consumption. The question that this study tried to answer was how the methods for calculating a water footprint of a hotel's food consumption can be improved for future usage in the tourism industry.

To do this, it was first important to find out what the contribution of food consumption was to the total water footprint of hotels. When it comes to the direct water footprint of hotels, it is found that the water that is directly used for food comprises only a small part of the total direct water use in hotels (between 5-15% of the total direct water use) (Gössling, 2001; Smith et al., 2009). It is however the embodied water that is used indirectly for the production of food which is much bigger than the total amount of water that is used in hotels, because of the different supply chains that are involved in the production of food (Cazcarro et al., 2014). This makes the indirect water footprint, which includes food consumption, more relevant than the direct water footprint in hotels (Gössling et al., 2012; Gössling, 2015). Food is, together with fuel the biggest component of the indirect water footprint where the majority of water is consumed (Cazcarro et a., 2014; Yang et al., 2011).

To see what a water footprint for a hotel's food consumption looks like, it was intended to apply the water footprint methodology that was developed by Hoekstra and Hung (2002) to the case of the W-Amsterdam hotel, situated in Amsterdam, The Netherlands. Two approaches were used to calculate the water footprint for food consumption of the W-Amsterdam hotel, by using the purchasing list that was provided by the hotel, and the water footprint data by Mekonnen & Hoekstra (2010a, 2010b). The first approach took the products from the purchasing list which are proven in the literature to have a high water footprint per kilogram. The second approach took the products from the purchase list which were bought the most, meaning products that were bought a 100 times or more, and assumed to represent the products with the highest amount of kilograms.

It became clear in the results of the first method that with this approach, the water footprint numbers of different product categories could be compared to each other, to make recommendations on how to lower the water footprint for food. The second approach gave an overall view of the water footprint for food for the W-Amsterdam hotel. By comparing the results of the two methods, it was found that the results were similar. This means that the two methods complement each other well, and it can therefore be concluded that the water footprint of the products that were included in the selection that was used in the two methods, shows a good representation of the total water footprint of the overall purchasing list.

However, difficulties were encountered during the process of calculating the water footprint for the W-Amsterdam hotel which should be addressed in future research. What affected this research most, was that various assumptions and simplifications had to be made because of several different reasons, mostly because of a limited time and a lack of information that was available. Therefore, it was not possible to take the space-time aspects of the water footprint into account, water footprints could not be calculated for the exact compositions of the products with their different ingredients in detail, and several products had to be excluded from the selections.

Another issue that was uncovered in this research, was the unknown relevance for the hotels. Since hotels are either not aware or not interested in the subject of the indirect water footprint, they are not eager to cooperate in such a research. The lack of data and information that is currently available on the subject of the indirect water footprint for food was also a difficulty which affected the research. This made it more difficult to calculate some parts of the water footprint, and therefore caused some of the limitations of this research.

So to improve the methods of calculating a water footprint for a hotel's food consumption for future usage in the tourism industry, it is important that more time is spent in looking into the exact origins and composition of different ingredients of the products in the purchase list. In this way, the water footprint analysis can become more detailed, and it can become visible in which parts of the world the supply chain of the hotel consumes its water for the production of the products that are destined for the hotel.

Furthermore, more research has to be done to provide more data to make the process of calculating a water footprint for food more easy. The water footprint should be calculated for more product categories and for more detailed products, so that the specified products of the purchase list can be calculated exactly and do not have to be generalized anymore. Hotels should also be made more aware of the subject in order for them to be more interested in it and more willing to research the topic. In this way, the topic can be researched more and knowledge about the subject can be created to find out more about what the indirect water footprint for food consumption for hotels looks like. This is important information to know and to include in sustainable water management, and only this first attempt at applying a water footprint analysis on a hotel which is situated in a water rich country such as The Netherlands is not enough to make conclusions on this subject matter in general. Nevertheless, this research provided a first step into the right direction, by raising more awareness and giving the subject of indirect water footprint in tourism the importance that it needs.

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