MOROCCO'S WATER CRISIS – CAN THE GROWING TOURISM SECTOR COPE WITH THE EFFECTS OF CLIMATE CHANGE?

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ABSTRACT

This study assesses how changes in climate will affect the water supply-demand relationship in Morocco and how hotels can better adapt to future water scarcity issues. Since a lot of studies have already focused on the Mediterranean, it is important to look at Morocco as an emerging tourism destination and additional water consumer. Due to climate change and socioeconomic development including tourism development, increasing pressure is put upon already scarce water resources in Morocco. By the end of the century, temperature is projected to have risen by 2-3°C and precipitation decreased by 40-60%, which enhances water stress significantly. Through literature review and desk research, a reduction target for the overall water demand has been determined to be around 40% of which 10% is attributed to the hotel industry. A fieldtrip to Morocco, which included informal interviews and questionnaires, helped to compile data on hotels' water consumption and water source. Eleven hotels participated in the study. On average, hotels are consuming 310 litres of water per guest night, which is mostly sourced from the public network/municipality or from wells. The gathered information has been used to develop adaptation strategies. Direct water saving options in hotels, the use of renewable water resources and desalination plants have been identified as viable options to reduce water consumption and to boost water supply. Changes in the water management and stewardship are pivotal for long-term sustainable development in Morocco.

Keywords: Climate change, tourism development, water supply and demand, water consumption, hotel water management, adaptation, Morocco

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1. INTRODUCTION

Water is life and potable fresh water is an essential resource in tourism (Gössling, 2015). In existing literature it is evident that tourism increases the overall water consumption in a region (Gössling et al., 2012) and that the water consumption of hotels guests often exceeds that of local inhabitants (International Tourism Partnership, 2017b). Accommodation is the main source of direct water consumption in tourism. In a hotel, fresh water is directly consumed in the bathroom (through using the shower, toilet and sink) to fill swimming pools, to irrigate gardens, to provide tourism activities like golf and to clean rooms and other facilities (Charara, Cashman, Bonnell & Gehr, 2011; De Stefano, 2004; Gössling, 2015). Water gets indirectly consumed through food and fossil fuels needed for transportation (Hadjikakou, Chenoweth & Miller., 2013). Table 1 gives an overview of how much water is used per guest night on average.

Table 1. Direct and indirect water use in tourism.

Water use category – direct	Min-max in L/guest night	Estimated average L/guest night
Accommodation	84–2425	350
Activities	10–875	20
Water use category – indirect	L/guest night	
Infrastructure	0.2	0.2
Fossil fuels for transport	5–2500	130
Energy use at hotel	0.3–200	75
Biofuels	2500	–
Food	4500–8000	6000
Other consumption	n.a.	n.a.
Total per tourist/guest night	4600–12,000	6575

Source: Gössling, 2015.

The demand will further increase, and this in an era of climate change, where water gets an even scarcer resource. Gössling (2015) recognized trends towards more water-intensive activities and towards higher-standard accommodation. He further proposes that this type of accommodation has significantly higher water use values (Gössling et al., 2012). It is projected that by 2030 the global overall water demand is likely to outstrip water supply by 40% (International Tourism Partnership, 2017b). Water demand is continuously increasing due to a growing population as well as urban and industrial development. Therefore, the Millennium Development Goals are emphasizing the need of reaching its target of increasing the population with reliable access to fresh water (Iglesias, Garrote, Flores & Moneo, 2007). Effective management of water resources is hence imperative to understand both direct and indirect water consumption. Bohdanowicz-Godfrey and Zientara (2015) found that all

hotels have the opportunity to reduce their water use by at least 20% per guest per night. The hotel industry is part of the rapidly growing tourism sector and thus, they are responsible to take action. A critical first step for hotels towards taking action is understanding their own water consumption. An appropriate tool is the calculation of the Water Footprint.

This study focuses on Morocco as an emerging tourism destination and as one of the most vulnerable regions of climate change impacts. Morocco is a semi-arid country lying in the Mediterranean, where water is a scarce resource. Water resources are irregular and limited in time and space (Taleb, 2006). The water availability in Morocco is already suffering from climate variability and changes due to climate change. Projections from the Intergovernmental Panel on Climate Change (IPCC) show an increase in temperature of about 2-3°C and a reduction in precipitation of 40-60% by 2100 (Rochdane, Reichert, Messouli, Babqiqi & Khebiza, 2012; see figure 1). Due to these changes, the water balance will be altered as well as the partitioning of precipitation between evapotranspiration, surface runoff, and groundwater flow (García-Ruiz, López-Moreno, Vicente-Serrano, Lasanta–Martínez & Beguería, 2011). This will result in changes in the water supply and the amount of water that is available for consumption.

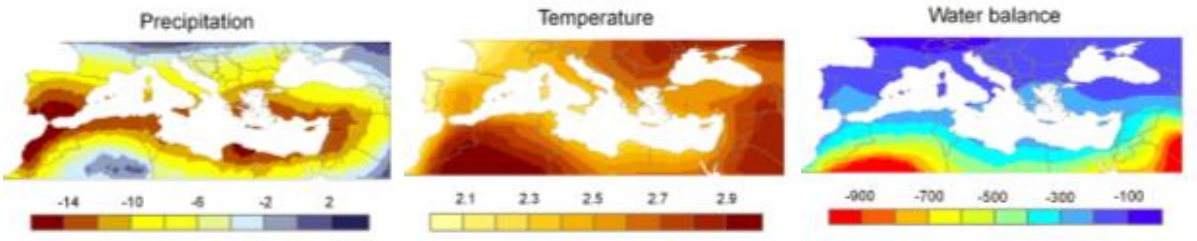

Figure 1. Mean annual climate changes in precipitation (P; in %), temperature (T; in °C) and water balance (P-T; in mm) projected for the Mediterranean between 1960-1990 and 2040-2070 (Source: García-Ruiz et al., 2011).

The Water Footprint (WF) is a concept that was developed by Arjen Hoekstra in 2002. The WF is a powerful tool to assess the amount of water used to produce goods and services we use (Water Footprint Network, n.d.). It comprises the blue, green and grey WF. While the blue WF consists of water that is being lost due to evaporation, transpiration or incorporation into a product or water that has been returned to a different catchment area, green water refers to rainwater in the ground-surface water body that is being taken up by plants. The grey WF indicates how much fresh water is required to assimilate pollutants (Water Footprint Network, n.d.). Schyns and Hoekstra (2014) calculated the WF for Morocco's production in the period of 1996-2005: 38.8 billion m^3 per year (see figure 2).

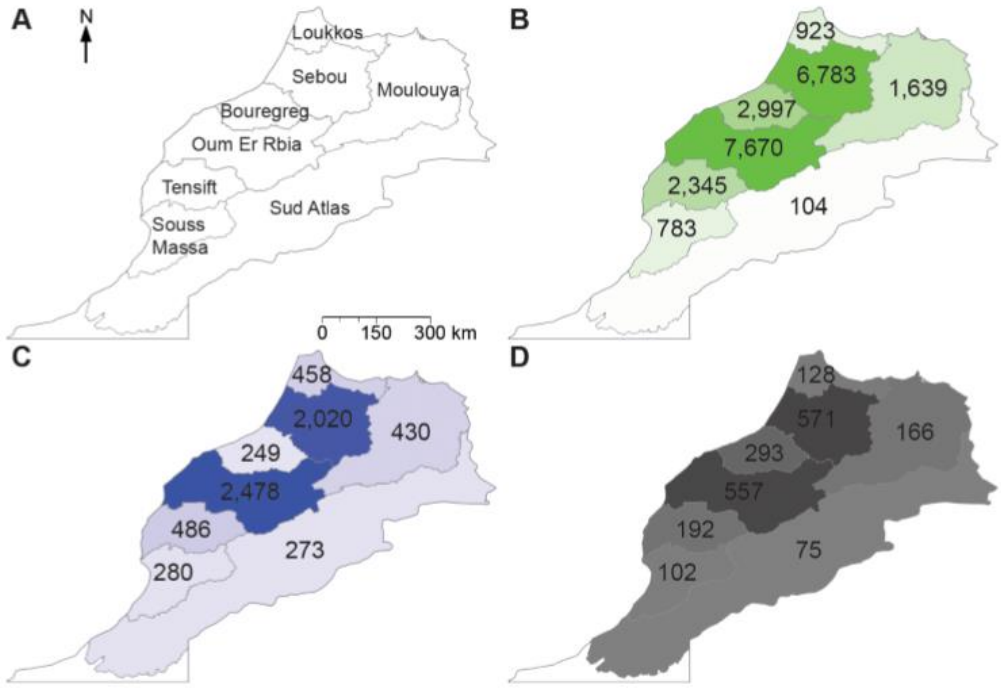

Figure 2. WF of Morocco's production per river basin. (A) shows Morocco's river basins, (B) the total green, (C) blue and (D) grey WF of Morocco's production in Mm^3/year (Source: Schyns and Hoekstra, 2014).

How tourism (activities) impact local water resources remains a largely understudied issue (Hadjikakou, Chenoweth & Miller, 2013). According to Tortella and Tirado (2011), limited research has been conducted on the relationship between tourism and water demand. Gössling, Hansson, Hörstmeier and Saggel (2002) reasons this with a lack of available data. Additionally, this gap exists because tourism appears to have a negligible impact on the water demand compared to other water users. Especially agriculture and the growing industrial economy are demanding a higher amount of water (Hadjikakou et al., 2013). International tourism only accounts for less than one per cent of national water use (Gössling et al., 2012). Not considered in this number by Gössling and his colleagues (2012) is, however, the spatial and temporal nature of tourism (Emmanual & Spence, 2009). Several calls are made in current literature to address the tourist water demand in arid destinations with water supply problems (Tortella & Tirado, 2011). A research gap also exists on the role of food in tourism-related water consumption. Furthermore, in terms of location many studies so far have focussed on the Mediterranean region in general (Cazcarro, Hoekstra and Chóliz, 2014; Hadjikakou et al., 2013; Kent, Newnham & Essex., 2002; Rico-Amoros, Olcina-Cantos & Sauri, 2009; Tekken & Kropp, 2015). The Mediterranean is seen as one of the most vulnerable regions to climate change and water scarcity. However, it is crucial to assess impacts on a local scale. Water scarcity issues are inherently local and Gössling (2015) argues that it is the local water use which affects sustainable water use and management. The distinction between local and global is important as it is difficult to say whether

water scarcity is due to insufficient supply or excess demand of water. Morocco was chosen as the destination for this study as it is one of the countries which will be highly affected by changing climate conditions and where tourism is forecasted to develop strongly (Gössling et al., 2012).

Tourism is a key economic sector in Morocco as an emerging tourism destination. With 3000 km of coastline, mountains, desert and a rich cultural history Morocco offers unique experiences for different types of tourists. Tourist arrival numbers rose from 2.6 million in 1995 to 10.3 million in 2016 (The World Bank, 2016b), which reflects an increase of 2% to 2015. The government of Morocco has launched the strategic plan *Vision 2020*, planning to reach 20 million tourists by doubling the size of the tourism sector until 2020. The Moroccan Tourism Minister Mr. Lahcen Haddad is visioning a sustained annual growth rate of 6% over the next 20 years (Morocco Ministry for Tourism, 2016) to make Morocco one of the 20 largest global destinations. Another plan called *Plan Azur* aims to create six additional seaside resorts to increase the bed capacity by 100,000 beds. The Ministry of Tourism represents tourism as an engine and "the major lever for acceleration of socio-economic growth" (Kingdom of Morocco – Ministry of Tourism, 2016). Tourism is also the second largest contributor to the national GDP (del Mar Alonso-Almeida, 2012) and offers 507,000 direct jobs within the industry. In 2015, the development of capacity has increased to more than 230,628 beds, of which most of them make up three, four and five star hotels (Kingdom of Morocco – Ministry of Tourism, 2016). This is why the focus of this study is laid on hotels in a warm climate, where gardens and pools are of relevance, as growing numbers of visitors will result in enhanced water consumption in the tourism industry.

In order to examine the climate change impacts on the water supply-demand relationship in Morocco and the implications for the hotel industry, this study will identify possibilities on how to better adapt to water scarcity.

1.1 Research Objective

The objective of this research is to examine the tension between water availability and tourism-related water use in the water scarce country Morocco and to develop strategies on how hotels can adapt to the projected changes in water supply and demand. A feasible reduction target for the overall water demand will be developed as well as a fair share of tourism for this target, which – if adhered to – should enable long-term sustainable management of water resources in the tourism industry. Identifying future water management challenges is of high importance. Climate change effects on the

water supply and changes in water demand will be investigated. Furthermore, it will be examined how much water is used within the tourism industry (represented by hotels) and how this influences the water availability in the local region. The study therefore assesses the water consumption of hotels in Morocco. Furthermore, it will be analysed how much water is available for consumption in the region of the selected hotel. In the end, climate change effects will be used to assess the future impacts on water availability and how that in turn impacts the tourism industry. Based on these results, strategies on how to adapt to future changes will be presented.

1.2 Research Question

To address the objective of this study, the following main research question will be answered in this paper:

What options do hotels in Morocco have to adapt to the region's projected changes in water scarcity?

This question is answered based on the case study in Morocco. Accordingly, a set of specific research questions (SRQ) has been developed to ease the operationalisation and to support the main research question:

SRQ1: How are water supply and water demand projected to change between now and 2100?
SRQ2: What is a desirable reduction target in overall water demand and what is a fair share of reduction effort for the hotel industry?
SRQ3: What is the water footprint of the hotels?
SRQ4: Given the hotels' water consumption, what are possible adaptation strategies to meet the reduction target for hotels?

Following this introduction and the objective of this study, a review of existent literature will identify what has already been found on this topic. Scientific literature on climate change impacts in the Mediterranean, of which Morocco is part of, and more specifically Morocco only will be reviewed. Focus is also laid upon water management (in the hotel industry) and tourism development in Morocco. Following this extensive literature review, results will be displayed and analysed per SRQ, on which the proposed adaptation strategies for the main research question are based. Finally, the results of this study will be discussed with the existing literature.

2. LITERATURE REVIEW

The following literature review will give insight into existing studies in the field of climate change impacts, the current and projected water situation in Morocco, tourism development and tourism-related water use and water management in the hotel industry.

2.1 Climate change scenarios

It is a fact that climate is changing (Stocker et al., 2013). The degree of how climate change will affect people and the environment is, however, uncertain. The IPCC developed several different climate change scenarios. These are dependent on climate factors and socioeconomic drivers. The main driving forces of future greenhouse gas trajectories of climate change are demographic, economic, social and technological change and development (Nakicenovic & Swart, 2000). Pivotal for the different scenarios are the Representative Concentration Pathways (RCPs) and Shared Socioeconomic Pathways (SSPs), which the IPCC replaced for the models developed in the Special Report on Emissions Scenario (SRES) in the fifth assessment report on climate change published in 2013. Earlier climate change scenarios were divided into six scenario groups corresponding to four families (A1, A2, B1 and B2; see appendix A for characteristics). The new system includes RCPs, which are based on the increase in radiative forcing through 2100 (see figure 3). RCP8.5 is also called a *business as usual* scenario. It assumes stable economic development and steadily rising global carbon emissions, with however no measures and policies implemented to reduce GHG emissions (Seif-Ennasr et al., 2016). SSPs are scenarios based on socioeconomic drivers. SSP2 is *business as usual* scenario, whereas SSP3 is a pessimistic scenario which assumes lower GDP growth, a higher population growth, and a lower rate of urbanization. In this study, a combination of distinctive scenarios has been used. The *Business as usual* approach used in this study is based on RCP8.5/SSP2.

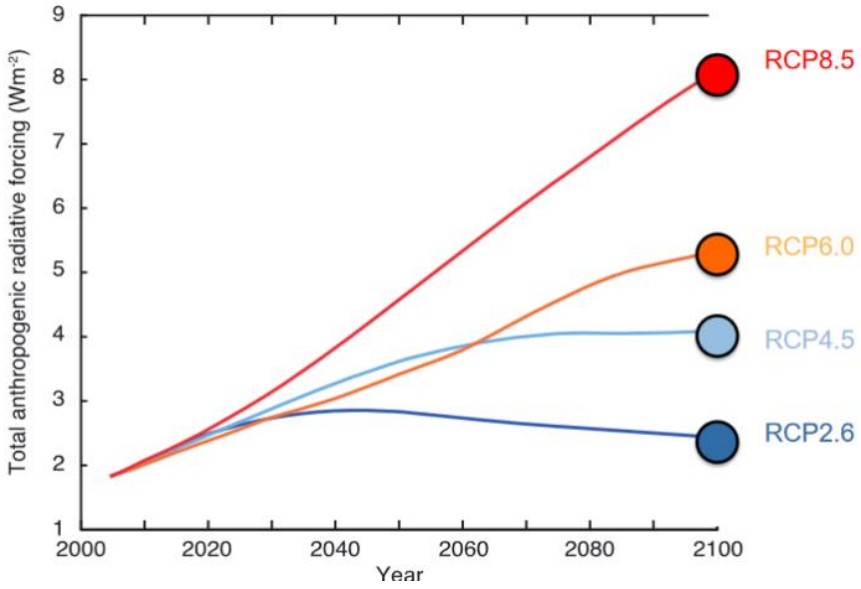

Figure 3. Representative Concentration Pathways (Source: Knutti, 2013)

2.2 Climate change implications in Morocco

A lot of climate change studies have focussed on the Mediterranean area, which has been identified as a climate change hotspot (Christensen et al., 2007) where 60 million people face water stress (Re, Sachhi, Mas-Pla, Menció & El Amrani, 2014). Water stressed areas are defined as areas with less than 500m³ of renewable water per capita per year. The Mediterranean is one of the leading holiday destinations in the world. According to De Stefano (2004), 30% of tourist arrivals are international and 25% of global revenues are generated through international tourism. Because of the international nature of tourism in the Mediterranean, a lot of awareness has been paid to energy issues and carbon emissions due to long distance air travel. This awareness can further be used to better understand and manage other environmental issues like water scarcity and the decline in the quality of water resources due to climate change (Hadjikakou et al, 2013 & World Water Assessment Programme, 2009).

Through climate change environmental and natural resources are undoubtedly threatened. Morocco is already under extensive pressure from changes in socioeconomic, agricultural and tourism development and already feels the effects of climate change (The World Bank Group, 2017). According to the Food and Agriculture Organization of the United Nations (FAO, 2004), 78% of the arid country is desert or dry zones meaning that Morocco faces special challenges from climate change. It is already bearing the brunt of a changing climate. Through a severe drought in 2015 the economic growth rate fell by 1.5% in 2016 (The World Bank, 2016a). This period of poor rain highly affected the harvest and wreaked havoc. Nevertheless, Morocco is often seen as a leader in charge against climate change

(Prisco, 2016). They adopted green policies and took on a triple win approach. Conserving natural resources and enhancing the resilience of agriculture, the backbone industry for employment, is key. The *Plan Vert* was introduced to cope with the threat of the changing climatic conditions and it incorporates adapting to and taking steps to reduce the impacts of climate change while creating new opportunities for the local community. For example, an effort is made to conserve underground aquifers which is a natural source of fresh water and, if kept in healthy conditions, replenishes itself. Policies aiming at conservation are crucial for sustainable development. Furthermore, Morocco owns the world's largest concentrated solar energy plant Noor-1, which lies on the fringe of the Sahara Desert. It will be able to power one million homes when completely finished in 2018 (Prisco, 2016). This has led Morocco to host the 2016 United Nations Climate Change Conference COP22 in Marrakech. Furthermore, Abengoa has started to construct a desalination plant at Morocco's Atlantic coastline near Agadir with a capacity of supplying 100,000m^3 of water daily to more than 500,000 people in the region (Pump Industry Analyist, 2015). Also, Abdelâdim Lhafi stated that Morocco now has 140 dams with a total storage of 18 billion cubic meters, which are the result of the strong water use policies that were implemented in the mid-20th century (el-Showk, 2017). However, as table 2 shows the demand for water rapidly increases despite less water being available. Even though this study is on one aquifer in Morocco, general conclusions can be made towards the whole of Morocco. Dams will hold less water, natural aquifers will not be able to recharge at the same pace and the quantity of renewable groundwater will decrease the more pessimistic the climate change scenario is.

Table 2. Impact of different climate change models on agricultural demand, drinking and industrial water, dam storage, natural aquifer recharge, renewable groundwater and water balance of the Chtouka aquifer projected for 2030-2050 (in Mm^3).

Climate change models and scenarios	Agricultural demand	Drinking and industrial water	Dam storage	Natural aquifer recharge	Renewable groundwater	Water balance
Current state	155.7	1.86	91.3	5.5	26.0	−40.3
CCLM, RCP 4.5	171.2	2.89	64.7	3.3	23.8	−85.6
CCLM, RCP 8.5	175.4	2.89	41.9	2.6	23.1	−113.3
HIRHAM, RCP 4.5	167.2	2.89	16.8	2.4	22.9	−107.7
HIRHAM, RCP 8.5	170.4	2.89	39.5	2.9	23.4	−133.1
RACMO, RCP 4.5	166.5	2.89	20.8	2.5	23.0	−125.6
RACMO, RCP 8.5	169.2	2.89	18.2	1.1	21.6	−132.3

Source: Seif-Ennasr et al., 2016.

In addition to the earlier mentioned plans on tourism development, Morocco also implemented the government led National Green Plan in response to current water scarcity aggravated by climate change (Seif-Ennasr et al., 2016). This Strategy aims at improving the management of groundwater resources, the increased demand for water used for irrigation, uncontrolled exploitation of aquifers and the reduction of renewable water resources (Choukr-Allah, Ragab & Rodriguez-Clemente, 2012).

Based on these results, it is more than evident that water resources in Morocco are limited. This is the case for all sectors as well as for the local community. Del Mar Alonso-Almeida (2012) states that only 58% of the rural population is able to enjoy access to water and disparities exist between urban and rural areas in terms of water supply (Koenig, 2000). In total, the actual renewable water resources per capita per year were below 900m³ in 2012, whereas the global average lies at 6000m³ (Tekken & Kropp, 2015). This is in line with the results of Re et al.'s study (2014), but lower than what has been found by Iglesias (2007, see table 3). Water resources will thus become even scarcer in the future.

Table 3. Water resource indicators (total freshwater resources, available resources, use and water availability) across selected countries in the Mediterranean.

Country	Total area ($\times 10^3$ km2)	Population (million)	Rainfall (mm/yr)	Internal usable water resources (km^3/yr)[a]	Usable water resources (km^3/yr)[b]	Internal groundwater (km^3/yr)[c]	Total water use (km^3/yr)	Total water use (% renewable)	Potential total usable water resources per capita (m^3/capita per year)
Algeria	2,382	32	89	13.90	14.32	1.70	5.74	40	473
Egypt	1,001	72	51	1.80	58.30	1.30	61.70	106	859
France	552	60	867	178.50	203.70	100.00	35.63	17	3,439
Greece	132	11	652	58.00	74.25	10.30	7.99	11	6,998
Israel	22	6.5	435	0.75	1.67	0.5	1.63	103	254
Italy	301	57	832	182.50	191.30	43.00	43.04	22	3,325
Libyan Arab J.	1,770	6	56	0.60	0.60	0.50	5.73	954	113
Morocco	447	31	346	29.00	29.00	10.00	12.23	42	971
Spain	506	41	636	111.20	111.50	29.90	35.90	32	2,794
Syrian Arab R.	180	18	252	7	26.26	4.2	20.6	100	1,403
Tunisia	164	10	313	4.15	4.56	1.45	2.58	57	482
Turkey	770	71	593	227	213	69	37	18	2,800

Source: Iglesias et al., 2007.

2.3 Water use in tourism development in Morocco

A lack of freshwater can hinder the development of tourism in Morocco. Tekken and Kropp (2015) found that changing conditions in climate are the most limiting constraint factor for the regional development. Especially in the north-east in Morocco, where agriculture is overexploit water use, concerns about the amount of water being available are high. Doubts exist about the sufficiency and the rise of water due to tourism-related water needs (Tekken & Kropp, 2015). Caffyn and Jobbins (2003) already noticed the increase in water demand due to socioeconomic growth and tourism development in 2003. Since tourism development can create more problems than it intends to solve, tourism needs to be managed in the right way. The following figure 4 gives an overview of strengths, weaknesses, opportunities and threat of the development of tourism in the north-east in Morocco (Tekken & Kropp, 2015).

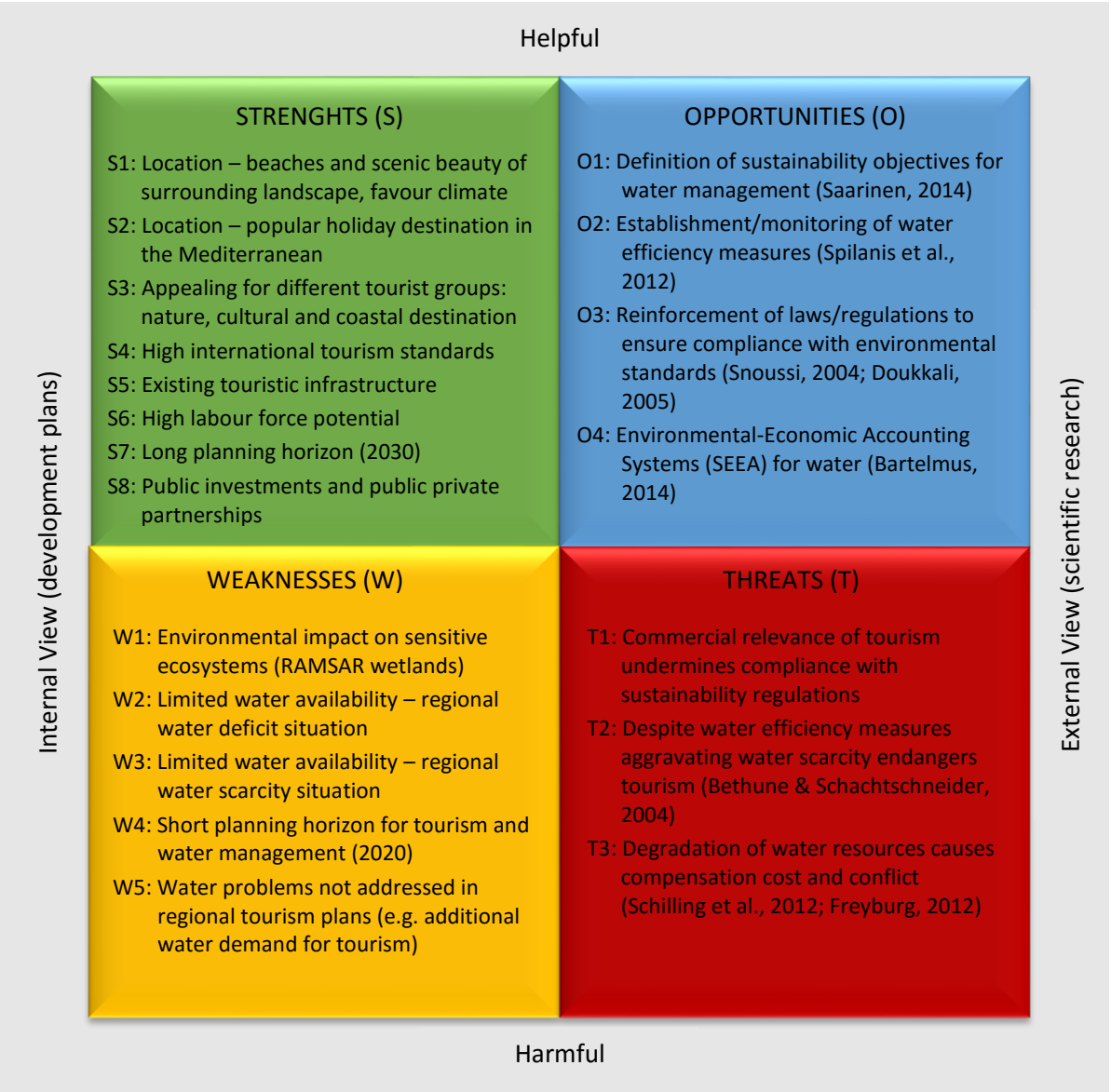

Figure 4. SWOT Analysis of tourism development in north-eastern Morocco (Source: Tekken & Kropp, 2015).

Rochdane and her colleagues (2012) studied the future of water resources in Moroccan's Rheraya watershed depending on different climate change and socioeconomic development scenarios until 2100. They found that water demand per capita use will significantly increase due to improved standard of life as well as continuous population growth. Through building new hotels in the area, the water demand for tourism as an expanding sector will rise as well, however, this growth is mild. The development of luxury hotels in the area can have a severe effect on the ecological problems. Even though advancements in the agricultural sector and more effective irrigation systems will lead to decreased water demand in this industry over the next thirty years, agriculture still demands the most water resources. Even though the impacts of climate change on water availability are widely known and general awareness exists for Morocco, which are scientifically substantiated, include warnings (Rijsberman, 2006; Gössling et al. 2002) and are outlining the critical situation (Snoussi, Haida & Imassi,

2002; Hoekstra & Chapagain, 2007), appropriate management with binding sustainability guidelines and criteria have hardly been established.

Despite Morocco being at the forefront of climate change adaptation and wanting to "emerge as a reference in the Mediterranean periphery on sustainable development" (Kingdom of Morocco – Ministry of Tourism, 2017), drastic improvements are necessary for the management of water resources in the tourism sector. Even though the Moroccan Ministry of Tourism established a sustainable tourism development approach in 2016 to strengthen sustainability criteria and standards (Kingdom of Morocco – Ministry of Tourism, 2016) political will is lacking, which avoids environmental laws and objectives to get implemented and supervised (Tekken & Kropp, 2015). The tourism sector is economically too important for the Moroccan industry that the urge to drastically set environmental rules is not evident, despite the serious risk of water scarcity. This is contrary to the goals of the Moroccan government of becoming a sustainable destination. Furthermore, a lack of compromise solutions is as constraining as a lack of financial means to moderate the water management (del Mar Alonso-Almeida, 2012). It is even referred to resource pragmatism, meaning that it is assumed water is constantly available despite adequate compensation measures are not existent and water is managed not effectively. This pragmatic thinking is nonetheless contrary to the regional reality on water resources (Schyns & Hoekstra, 2014; Tekken & Kropp, 2012). Hadjikakou et al. (2013) among other scientists recognises the importance and claims that "the impact of tourism on water resources should be viewed as a key local sustainability challenge" (p. 549), especially in destinations facing water scarcity. Anyhow, considerations of environmental friendly practices have often been overridden by decisions made by the government. Caffyn and Jobbins (2003), who were studying the governance and stakeholder interaction in the development of coastal tourism in Morocco, found that the governance structure (top-down approach) does not have the capacity to govern scarce natural resources and complex coastal environments, and therefore demands change in the management of water resources.

2.4 Water consumption and stewardship in the hotel industry

Water use in a hotel can be categorised into six domains: the guest room, laundry, kitchen, swimming pool, gardens and air conditioning (del Mar Alonso-Almeida, 2012). Not all of these domains account for the same amount of water. A study in the Vietnamese hotel industry, whose current and future water situation is and will be similar to the one in Morocco, showed that the guest room is the area with the highest water consumption (Kumar, 2005). Furthermore, the total water consumption in a hotel increases with the service level. While the level of a luxury five-star hotel lies at around 600 litres per bed-night, only half of it is used in a three-star hotel (del Mar Alonso-Almeida, 2012; see table 4).

Table 4. Levels of water consumption by category of accommodation in Morocco.

Tourist company	Water consumption standards
Luxury 5-star hotel	600l/bed-night
5-star hotel/riad	500l/bed-night
4-star hotel or equivalent	400l/bed-night
3-star hotel or equivalent	300l/bed-night

Source: Del Mar Alonso-Almeida (2012) and Eurostat (2009)

Several studies exist on the water use in comparison to the hotel size. In America, 382 litres per room per day are consumed on average for smaller hotels with fewer than 75 rooms, whereas hotel with more than 500 rooms can use up to 786 litres (Redlin & De Roos, 1991). Bohdanowicz and Martinac (2007) state that the size of the hotel is the most determining factor of water consumption. They furthermore added that the water quantity in European hotels increases if a hotel is classified as luxury. However, the water quantity does not only highly vary between different kinds of accommodation but it is also dependent on the area where it is located in. While the average daily water consumption in a hotel lies at around 863 litres per person in Barbados (Charara et al., 2011), Meade and Gonzalez-Morel (1999) calculated that this number ranges from 438-1326 litres per person in Jamaica. In Hilton and Scandic hotels, 215-515 litres are consumed daily per person (Bohdanowicz & Martinac, 2007), which is in line with Hamele's and Eckhardt's (2006) study among hotels in the European Union, which use about 231 litres per person. Outstanding are the numbers of the International Tourism Partnership (ITP). They estimated an annual water consumption of 51.276m³ which equals 819 litres per guest in a 270-room hotel in Lisbon, Portugal (Green Hotelier, 2013). Another key factor determining the amount of water being consumed is season. According to Rankin's and Rousseau's (2006) research in South Africa, 30-40% more water is being consumed in summer, which is the same as in Barbados. July and August are considered the most consuming months (Charara et al., 2011).

The Environmental footprint study of Accor (AccorHotels, 2016) reveals where most of the direct water in hotels is consumed. According to their study, 40-45% of water is used in guestrooms for showers, taps and toilets, 15-25% for the kitchen and restaurants, 15-20% for public toilets, 0-10% for laundry, 0-10% for the watering of green spaces and 0-5% for the swimming pool (see appendix B). Next to direct water consumption by guests, fixed consumption is always incorporated due to cleaning and maintenance (Baberán, Egea, Gracia-de-Rentería & Salvador, 2013). The numbers of the ITP are generally in line with these (33% for the guestrooms, 17% for kitchens, 16% for public toilets, 5% for laundry, 4% for gardens, 3% for the snack bar and the rest for other sources which are not metered (Green Hotelier, 2013).

International hotel chains developed tools to measure and record water and energy usage. For instance, Hilton International uses their internal water measurement tool *Lightstay*. They leveraged this corporate responsibility platform to measure the performance, which data allows them to improve the hotels management on energy, water and waste. Hilton was able to reduce water consumption by 16.7% from 2009 to 2015 and by 1.4% in 2015 from 2014 only. The first amount represents 5272 swimming pools. Hilton is also committed to help reaching the Sustainable Development Goals of the United Nations (Hilton, 2017).

Hyatt changed operations to save water, for example by using low-flow fixtures, recycling water and collecting condensate from cooling systems. Through these changes, the hotel chain was able to reduce their water consumption per guest night by 18-21% from 2006 to 2015, depending on the geographical location (Hyatt, 2016).

The Accor Hotel Group, which includes hotels of the brands Sofitel, Ibis, Pullman and Mercure, have launched platform called *Planet 21 Research* to share knowledge about sustainable development and innovation in the hotel industry (AccorHotels, 2016). With the *Planet 21 Research* programme, AccorHotels was able to reduce water consumption by 8.4% between 2011 and 2015 worldwide. Understanding the impact of the hotels activities is in their view pivotal for a sustainable development of the tourism sector. Other studies have focused on the socio-economic as well as the environmental footprint. Regarding the water consumption footprint, the study in 2016 (AccorHotels, 2016) also included indirect impacts such as food. In AccorHotels, the consumption of food accounts for the biggest source of water use and pollution. In total, 544 million m^3 (Mm^3) of water is being consumed by the AccorHotels, which is as much water as 438,000 Europeans are using every year. From this amount, only 10% is however directly consumed by hotels, the main part (86%) is used for agriculture and for food production (AccorHotels, 2016). Moreover, in 2014, AccorHotels began to use the tool Aqueduct developed by the World Resource Institute (WRI) to map water issues on a local scale. This tool assesses the water access risk hotels might face. According to this data, most areas in Morocco are currently exposed to ‘high risk’ or ‘extremely high risk’ regarding water risk. The analysis of this data will be presented in the results chapters.

3. METHODS

3.1 Research Design

This study explores possible adaptation strategies for hotels to cope with projected changes in water supply and water demand in an era of climate change. The options have been developed based on the assessment of the water consumption of several hotels in Morocco. Since the focus of the study lays on a holistic understanding of the phenomena of water management in a hotel, the design of a case study has been adopted. The selected case of research is the direct water consumption in hotels in Morocco.

The exploratory study has been investigated from a mixed-method approach. Both qualitative and quantitative research was used to carry out empirical data collection. Bryman (2008), who critically views the integration of both qualitative and quantitative components in one research, also acknowledges the opportunity of combining these two through focusing on different aspects and assess their relationship. Since internet use in Morocco is limited and face-to-face communication is common, a 2.5-week fieldtrip to Morocco was necessary in order to gather the data needed onsite. The fieldtrip took place in May and different locations have been visited to gather data from different hotels all around Morocco. The research phase in Morocco has been split into getting accustomed to the country in terms of climate, food and traditions, conducting the research, data gathering and start analysing the obtained data.

3.2 Data Collection and Analysis

As already stated, both qualitative and quantitative data have been used to answer the main research question. This combination allowed for more comprehensive study results.

Regarding the first specific research question (How are water supply and water demand projected to change between now and 2100?), desk research will be carried out to collect evidence. Desk research is crucial to assess what is already known about the research question. However, only English literature has been considered. By reviewing literature and gathering data this SRQ has been answered. Focus will be laid upon how climate change will impact Morocco and the hotels' water stewardship, how water supply will consequently change and how water demand will change due to socio-economic factors. An understanding of both water supply and water demand is thus important. Therefore, the reason for these changes will be discussed in the chapter as well.

To answer the second specific research question (What is a desirable reduction target in overall water demand and what is a fair share of reduction effort for the hotel industry?), information and data from SRQ1 was used to estimate a reduction target in water demand and to set a fair share of reduction effort for tourism. Since no study exists on the overall water demand in Morocco, this number had to be estimated. Consequently, the study of Rochdane and her colleagues (2012) on the water availability and demand in one specific watershed has been used as a base to calculate and estimate the demand of the whole country. By analysing information about the unmet water demand (for all sectors) for two different climate change scenarios, indications about the overall water demand in Morocco can be given. Through this, the water demand per capita per day is available and offers insight into how much the water needs to be reduced to be sustainable in the long-term. The actual target has been set based on a combination of recommendations in the literature and acquired knowledge. A more precise and stepwise explanation of how this calculation was done is given in the results section.
The second part of the second specific research question has been answered through the analysis of how much water the tourism industry represented by the hotel industry is demanding from the overall water demand. Economical and societal consequences of the hotel have been considered. The fair share aims at reducing the water consumption significantly and the developed target will be the goal for the strategies proposed in SRQ4 to reach.

The third specific research question (What is the water footprint of the hotels?) discloses the actual water consumption in hotels. In order to gather the relevant data during the field research for the assessment, qualitative methods have been used. While the content of the data gathering consisted of quantitative data, qualitative methods have been used to obtain these data. As experienced in the beginning of the research phase, telephone calls and E-mails were not a successful communication tool to make appointments or receive information prior to the trip. Because of this (technical) obstacle a questionnaire has been developed, through which the necessary data was obtained during informal interviews with the contact person in the hotel. This empirical approach to obtain the data has been selected as the questionnaire guided the structure of the informal interviews.

The questionnaire (see appendix C) has been developed in the beginning of the field research phase and asks for quantitative data mostly. The aim of this survey is to gather the relevant data for the assessment of the water situation in hotels. Most relevant data include the number of guest nights per year and the total annual water consumption. The designed questionnaire is based on variables needed for the calculation of the water consumption. Therefore, the tool of the ITP has been used as a base. In partnership with KMPG and 18 global hotel companies, the ITP launched a tool to measure

and record on water use: the Hotel Water Management Initiative (HWMI, International Tourism Partnership, 2017a). The HWMI methodology and tool is free of charge and is accessible for all hotels worldwide. It provides insight into the variables needed to calculate the direct water consumption of hotels, more explicitly the amount of water used per occupied room and, if data are available, also per guest per night. This tool has been used as a base and adapted to meet the goal of this study. However, food has been left out for this study as the scope of additionally assessing the so called 'Water Foodprint' is too wide for this research frame.

The designed questionnaire includes five sections. The first section asks for general data like the hotel name, the service level, the number of rooms and the average number of guest nights per year. This is important to be able to categorize the hotels that participated later in the data analysis phase. Section two is about potential pools, gardens and laundry. In the case that the hotel cannot indicate its total water consumption, data about the size of the pool, the total area of outside space that gets irrigated or tons of laundry in the hotel per year, can be used to estimate the hotel's water use. For the direct water consumption in the hotel, the third section is relevant. It specifically asks about the water use in the hotel. Not only does it ask for the total amount of water consumed in the hotel, but also for the amount of water used by category (guest room including shower, toilet and sink, swimming pool, irrigation, kitchen, laundry). The next section is designed to gather data on where the water that is used in the hotel is coming from and what percentage of the overall use is coming from which water source. The last section forms the end and thanks participants for their participation. They have the option to enter their email addresses to receive options on how to better adapt to changes in water scarcity when the study is done.

No responses have been recorded after sending out the online questionnaire to more than a hundred hotels. This unexpected (technical) obstacle would have eventually been solved by showing up personally in the before contacted hotels for informal interviews to take place. Therefore, convenient sampling has been used. Since the aim was to get an overview of how much water different hotels are using, hotels in various areas of Morocco have been approached. The first contact person in every hotel was always the receptionist. After introducing myself, and explaining the purpose of my study, the contact person eventually referred me to another hotel worker who is responsible for the water and energy consumption of the hotel and who was able to answer my questions. However, in most cases the responsible contact person was not available. In few cases the receptionist was also able to provide the information needed, if he/she had the permission to distribute the information. If the hotel manager was not available, the questionnaire was left at the hotel and picked up a few hours or days later depending on when it would get filled out.

Eventually, the snowball sampling has been applied. Through engaging in social activities during the fieldtrip, I got to know locals who were able to help me with this study and who had contacts with hotels. Since they were native Arabic speakers they were able to translate the purpose of the study and questions into Arabic and/or French. This eased the data collection and more hotels were willing to participate. The use of a translator was therefore helpful and unavoidable because even staff of some four- and five star hotels were not able to communicate with me in English. In the end more than a hundred hotels have been approached and eleven answers recorded.

To identify the water demand of tourism in the region of the hotel in Morocco, the plan was to conduct a WF assessment of a selected hotel in Morocco based on the results of the questionnaire. The WF should have been calculated for the hotel, thus representing the direct water consumption. From the founders of the WF a calculation for both a hotel does not exist yet. However, since this was not possible because of a lack of data, the water consumption has been assessed differently. The questionnaire has been used to identify the total amount of water used and where the water is extracted from. These information have been summarized in a table. Categories have been developed based on the size and service level of the hotels that participated in the study. Since the number of guest nights and the total water quantity is known, averages were able to be calculated. Furthermore, additional essential information on the water situation of the different hotels, which have been gathered in informal discussions with the hotel staff, have been involved in the analysis of the water situation. The informal conversations usually took place in the hotel with the responsible target person. The questionnaire served as a guide and helped structuring the conversation to gather the required data. The questionnaire also includes open-ended questions to get a better overview of the hotel staff's knowledge about the water situation of the hotel. They allow for discussion and that the target person is able to critically reflect upon them. According to Bryman (2008), this type of questions is useful to understand a certain phenomenon. Researchers can "seek both clarification and elaboration in the given answers" (p. 123; May, 2001) through discussions with the target group.

To disclose the last specific research question (Given the hotel's water consumption, what are possible adaptation strategies to meet the reduction target for hotels?), adaptation strategies and options to reduce direct water consumption will be developed based on the calculations of the WF and the set reduction targets. These options include water saving measurements to reduce the direct water consumption in different areas in the hotel like guestroom, pool, kitchen and garden. The options also deal with water management strategies on how to manage water resources more sustainable and what can be done on the government level to encourage private-public partnerships to increase the

knowledge about the importance of water scarcity issues among hotel staff. These options are based on reviewed literature and the analysis of the answered SRQ's.

These specific research questions pave the way to answer the main research question (What options do hotels in Morocco have to adapt to the region's projected changes in water scarcity?), whose answer is based on the results found in the SRQ's. The following framework visualises this pathway.

3.3 Framework

Based on the approach taken on in the methodology, a conceptual framework has been developed to visualise the interaction between the variables and to indicate how to address the research questions (see figure 5). The framework indicates how the different variables and topics of this study are connected.

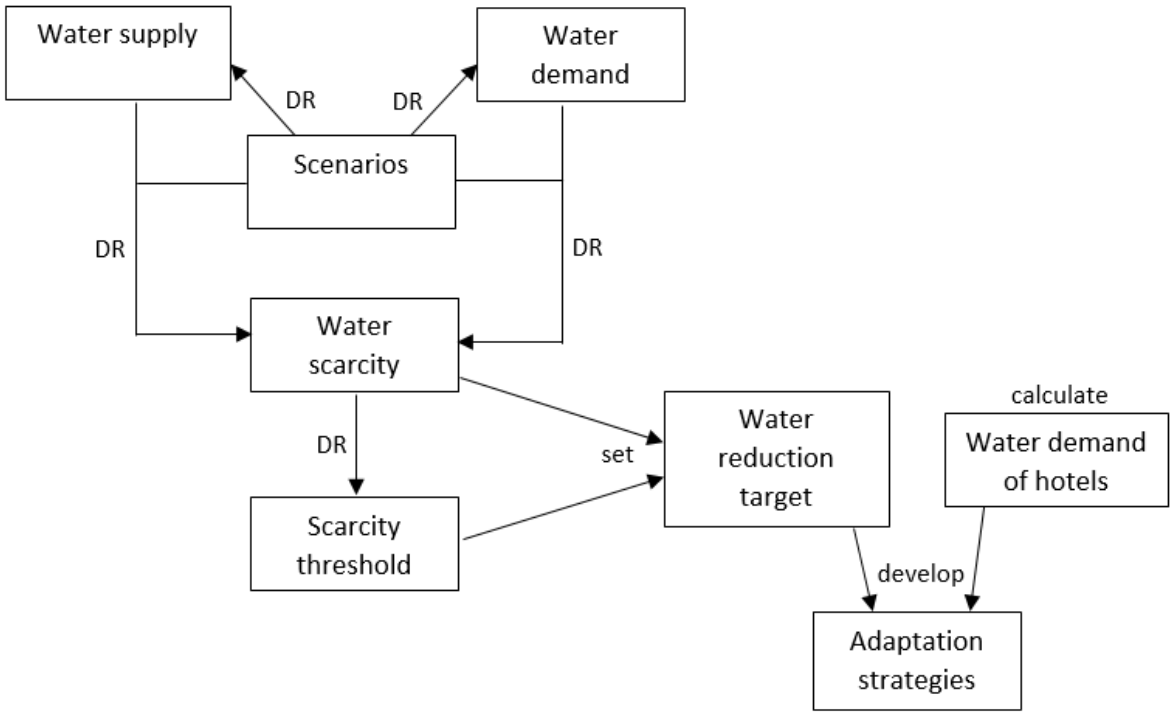

Figure 5. Conceptual framework of this study (DR = Desk research).

4. CHANGES IN WATER SUPPLY AND WATER DEMAND

To answer the first specific research question SRQ1 (**How are water supply and water demand projected to change between now and 2100?)**, desk research and literature review has been conducted.

Water supply and water demand are changing because of different reasons. While changes in water supply are driven by climate change, changes in water demand are mostly due to socioeconomic development and growth. In order to assess the degree to how much the water supply-demand relationship will alter in the future, different climate change scenarios are necessary.

The quantitative results for this specific research question are retrieved from a study of the World Resource Institute written by Luck, Landis and Gassert (2015). The Baseline is the period from 1950 to 2100. The future is defined as the period between 2030 and 2050. The overall results of this study have shown rapid increases in water stress (based on the relation of water supply and demand) across many regions. Water stress is used as an indicator for water resource competition and is defined as the withdrawals-to-availability ratio (Alcamo et al., 2003). The study found that understanding water demand increase is as important as are changes in water supply. In most countries growing water demand will outstrip the amount of water available, which leads to an increase in water stress. This is especially the case for most regions in North America, the Mediterranean, Middle East and southern Australia. Only in small parts in northern Europe, the north Pacific coastline in South America and western China water stress is projected to decrease. In Morocco, the change in water stress will be extremely high (>80%) west of the Atlas Mountains and medium to high (20-40%) in the east of the Atlas mountain range in 2040 under the *business as usual* scenario. This shows that water scarcity will be the result of changes in climate. Competition for scarce water resources will be enhanced and droughts will become more frequent. Figure 6 indicates the projected changes of water stress of different regions in Morocco in 2040 in more detail. In contrary to most parts in the world, in Morocco the increase in water stress is due to the strong decrease in water supply rather than due to the increase in water demand. Nevertheless, both factors contribute to more intense water stress.

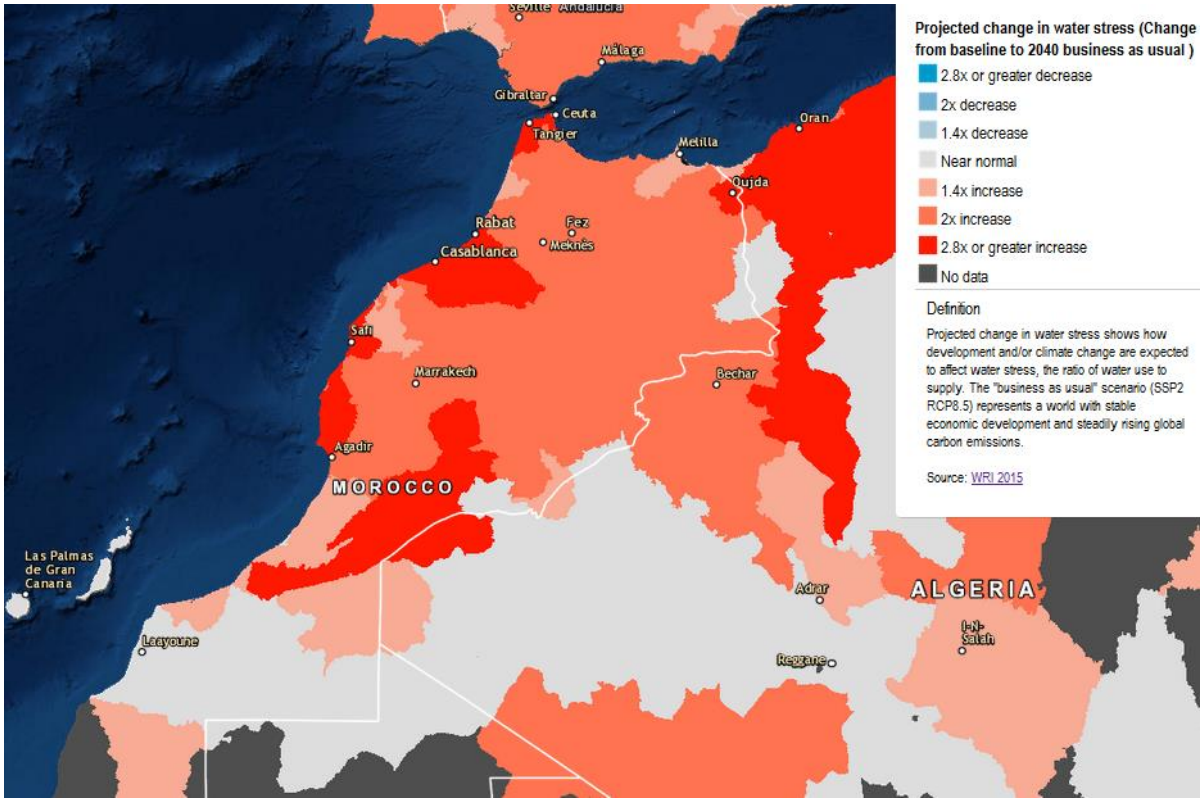

Figure 6. Projected changes in water stress from historical conditions to 2040 under the *business as usual* scenario.

4.1 Water supply

In order to be able to explain changes in water supply, the reason for this change towards water scarcity needs to be known. According to scientific studies, decreasing water supply is mainly due to changing climatic conditions and especially due to changes in precipitation and temperature. Giorgi and Lionello (2008) present in their study climate change projections over the Mediterranean for 2071-2100 based on recent and comprehensive ensemble climate change simulations. According to their study, which shows a consistent picture of climate change in the Mediterranean area, precipitation will decrease, temperatures will rise and inter annual variability will increase as well. Drier and warmer conditions in the Mediterranean will be the result.

In terms of precipitation, the projected average change in Morocco lies at around -20 to -40% in every season by 2071-2100 (Giorgi & Lionello, 2008; see figure 7). However, the most intense decrease of precipitation is projected to be in the summer months, namely June, July and August. This is the forecast for the A1B scenario, which assumes very rapid innovative technological development, economic growth, population growth with a peak in the middle of the 21st century and decline afterwards as well as a balance between all sources of energy (Metz, 2001). Additionally,

concentrations of CO2 are kept in the middle of the range at about 700ppm by 2100 (Giorgi & Lionello, 2008).

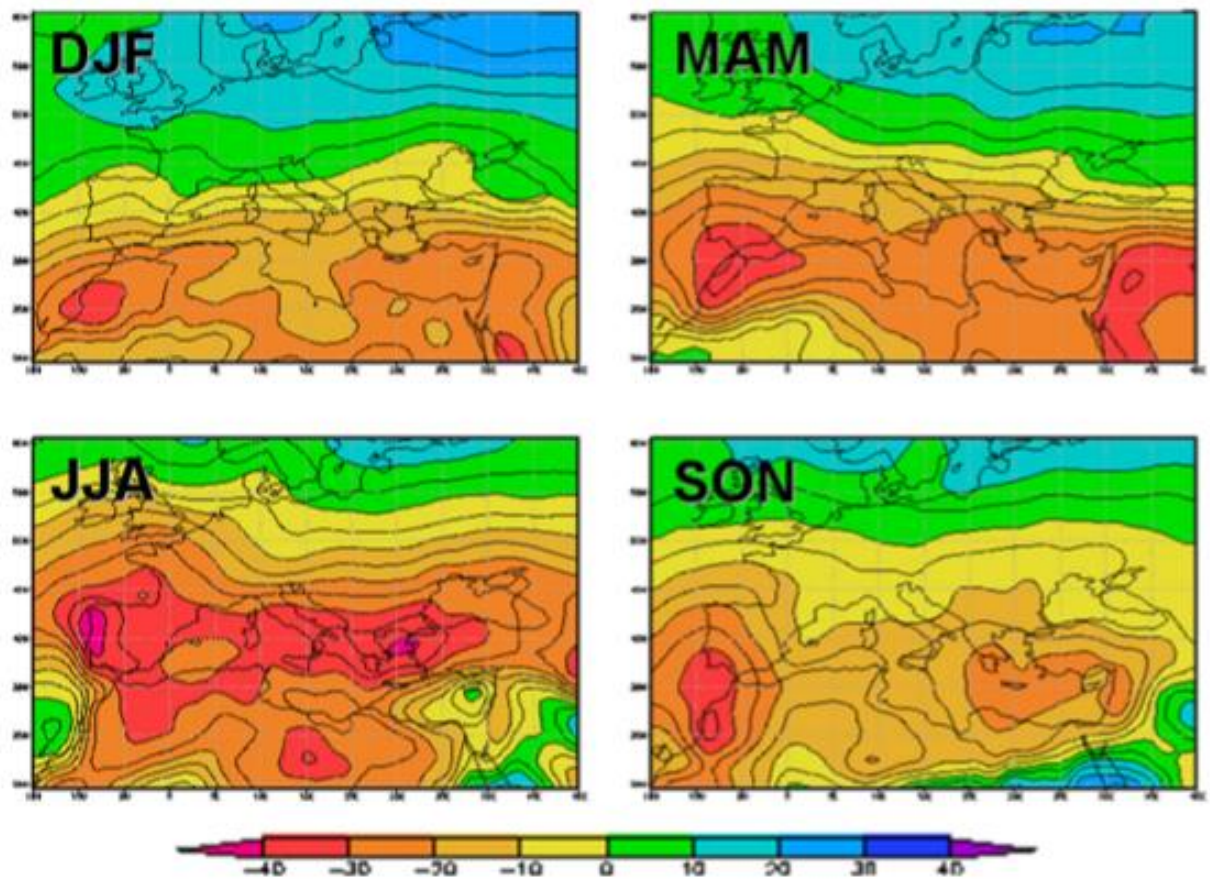

Figure 7. Average precipitation changes (in %, 2071-2100 minus 1961-1990) for the A1B scenario for the four seasons. DJG is December-January-February, MAM is March-April-May, JJA is June-July-August and SON is September-October-November (Source: Giorgi & Lionello, 2008).

As shown in figure 8 average surface air temperature will increase in every region around the Mediterranean by 2071-2100 by at least 1°C. In Morocco, the temperature will increase at least 2°C in every season, however, the maximum of warming is exhibited during summer when it can get up to 5°C warmer on average than it was in 1961-1990. Warming will be pronounced.

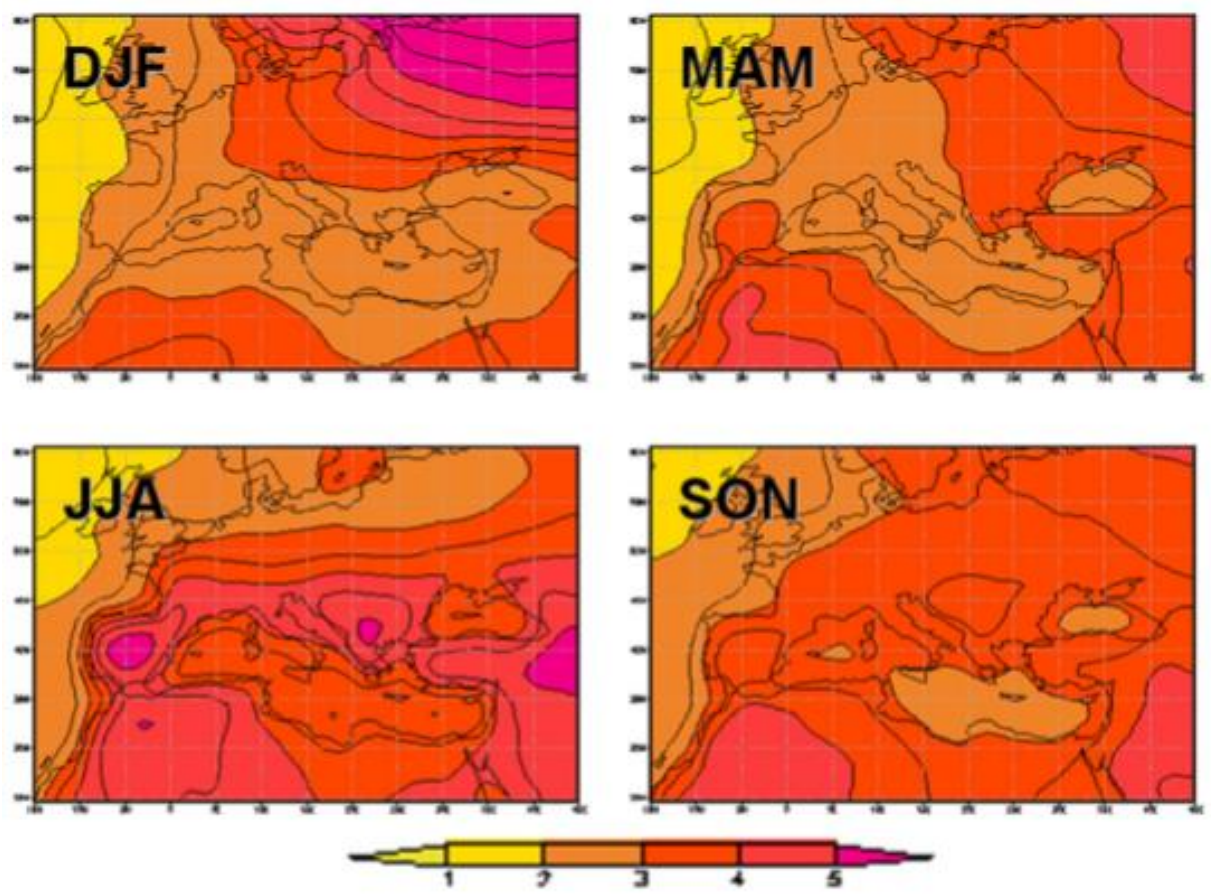

Figure 8. Average surface air temperature changes (in °C, 2071-2100 minus 1961-1990) for the A1B scenario for the four seasons. DJG is December-January-February, MAM is March-April-May, JJA is June-July-August and SON is September-October-November (Source: Giorgi & Lionello, 2008).

Changes in precipitation and surface air temperature are being triggered by climate change and have an impact on the water supply as they lead to less rainfall, enhanced evaporation and can cause furthermore depleted aquifers and less groundwater being available. Reductions in soil moisture will additionally contribute to more regions that will experience droughts (Rochdane et al., 2012).
The indicator for the water supply is the total blue water (renewable surface water). Water availability is essential for all operations of life. The change of the water supply in a given area is calculated by dividing the 21-year mean centred on 2020, 2030 and 2040 around the target year by the baseline period of 1950-2010.

On a global scale, water supply will lessen especially in the midlatitudes. Due to an increase in global temperature, the anticipated poleward Hadley cell will expand meaning that the areas around the midlatitudes are likely to become drier in the future (Kang & Lu, 2012). Figure 9 shows the change in water supply worldwide and hashing indicates the weighted coefficient of variance between model members. As it is visible in the map, the Mediterranean and Morocco are areas where water supply

will dramatically decrease in the future. However, the hashing on the Sahara desert does indicate uncertainty and that deviation can be high.

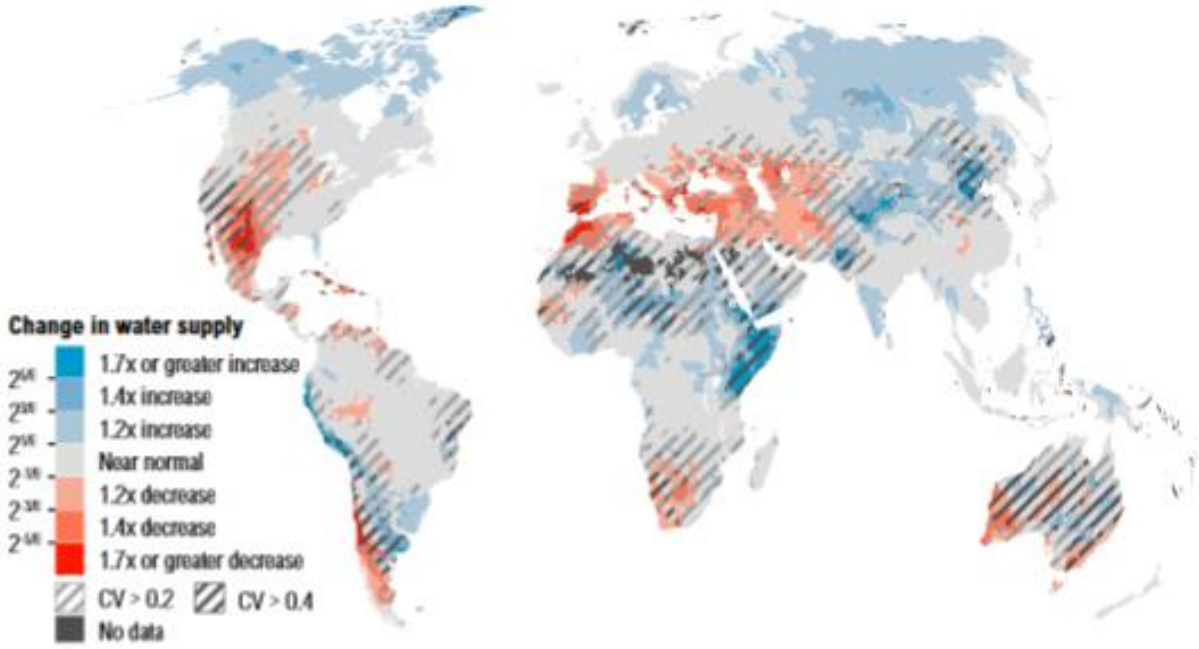

Figure 9. Change in water supply on a global scale. Hashing refers to standard deviations. No hashing corresponds to 0-1, light hashing to 1-2 and dark hashing to >2 categories on the legend (Source: Luck et al., 2015).

In every part in Morocco the supply of fresh water will decrease. As can be seen in figure 10 the water supply is expected to decrease by 1.4x to 1.7x from the baseline to 2040 under the *business as usual* model (SSP2 RCP8.5). This proves Morocco as one of the most vulnerable regions where climate change is having the most severe impact. This harsh decrease in water supply will result in less water being available for use by 2040 because fresh water reservoirs and basins are being prevented from keeping up with the rising demand of personal and industrial water use. Furthermore, soil moisture will decrease.

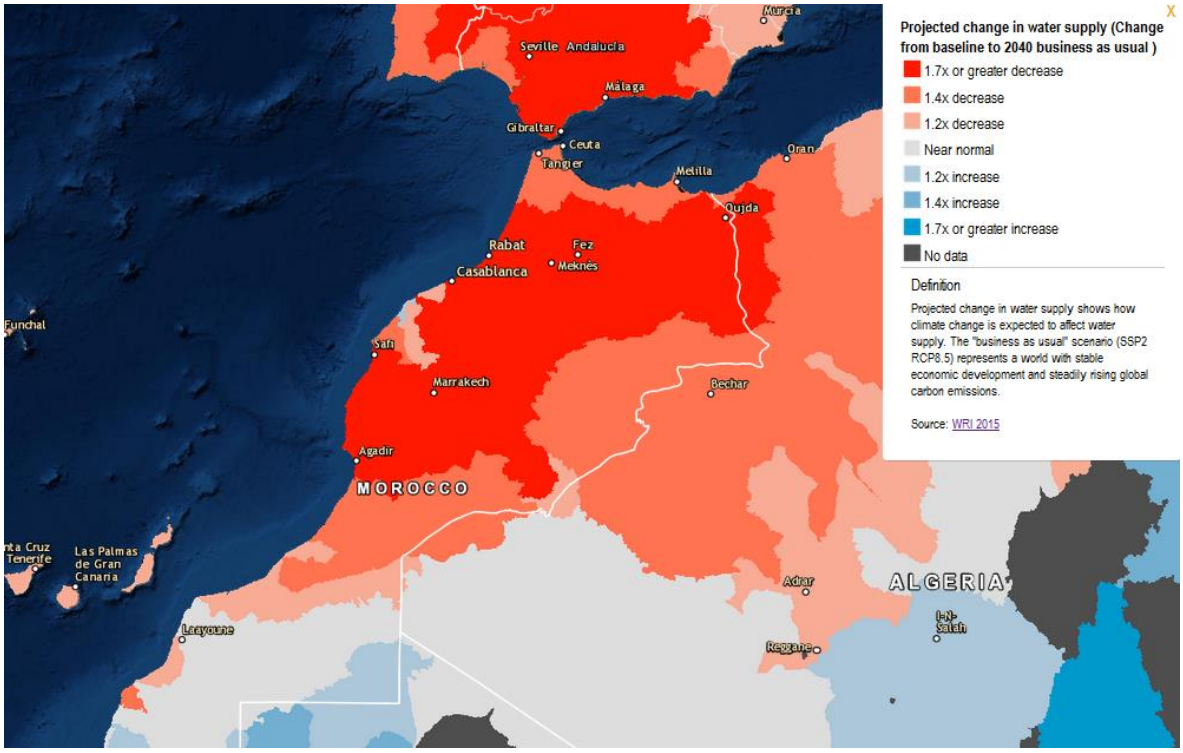

Figure 10. Projected changes in water supply from historical conditions to 2040 under the *business as usual* scenario.

4.2 Water demand

Demand of water is steadily increasing (Hadjikakou et al., 2013). Not only is the demand for water rising, the quality of the water available is more and more of decreasing quality, which increases the need of more fresh water (Re et al., 2014). The amount of fresh water being available is mainly due to socioeconomic development and growth. Currently, Morocco has a population of 35.2 million with a projected increase to almost 44 million inhabitants in 2050 (World Population Review, 2017). By 2020, tourism arrival numbers are projected to lie around 15.2 million (Gössling et al., 2012). Especially population rise and industrial development are the main factors contributing to a higher water demand. Through technological advancement, pipes are able to go deeper, depleting groundwater storages even more. The development of tourism demands more water as well and luxury hotel sites often include golf areas and gardens, which need to be kept irrigated.

Water demand is measured as water withdrawals and consumptive use. The amount of projected change has been calculated by dividing the water withdrawals for the future target year by the withdrawals from the baseline year 2010. Significant increase in water demand is found in underdeveloped and developing areas. Baseline demand is very low meaning that socioeconomic changes as population growth and rapid urbanization will have an even more striking effect.

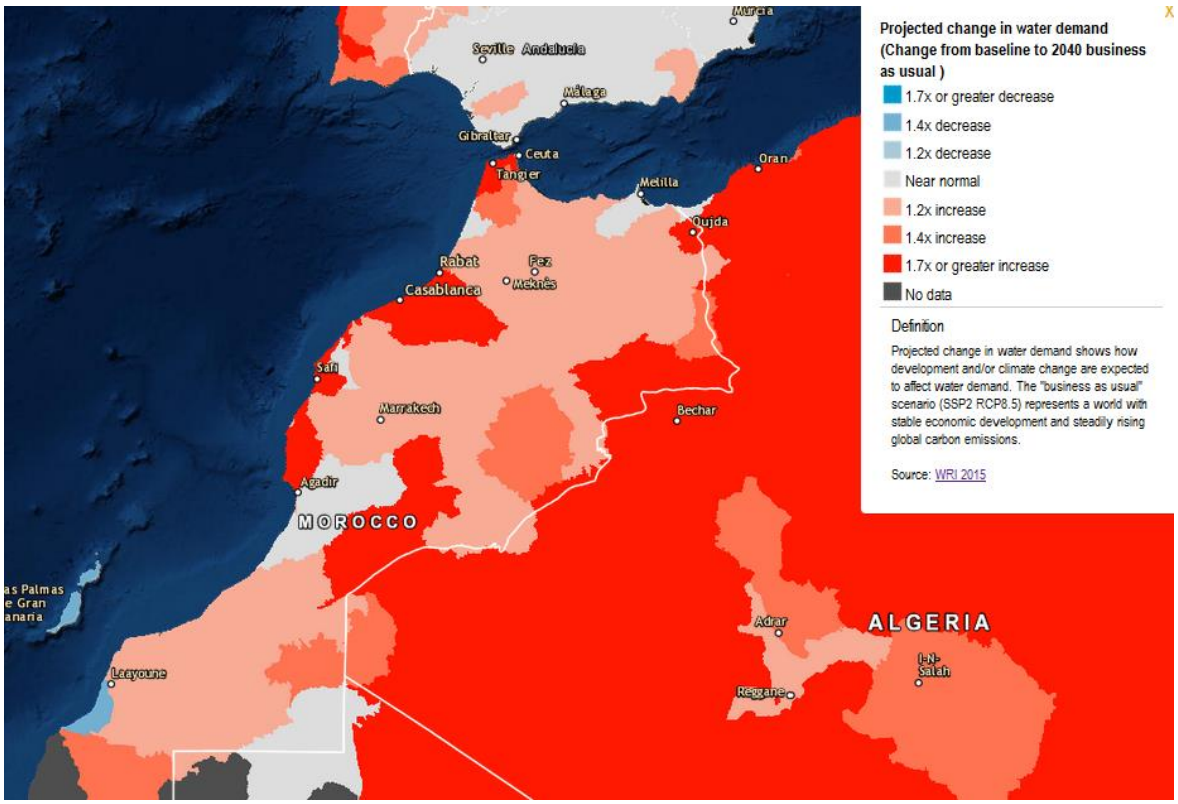

Figure 11. Projected changes in water demand from historical conditions to 2040 under the *business as usual* scenario.

Overall increase in water demand is expected throughout Morocco. However, as can be seen in figure 11 the amount of water demanded in the future varies within the country. While a strong increase of 1.7x or an even greater increase in respect to the baseline for 2040 is projected in many separated parts of the country, for example along the west coast and in the southwest, the water demand is projected to increase by 1.2x in the mainland of Morocco. In the southeast as well as around Melilla in the northeast the change will be near normal/not as determining.

In conclusion, it can be stated that even though the rapid change in water demand outstrips water supply worldwide, this is not the case for Morocco. In Morocco, the increase in water stress is primarily driven by the decrease in water supply than in the increase of water demand. By 2040, water supply will lessen by 1.4x to 1.7x. This is due to changes in climatic conditions through which temperatures are projected to increase and precipitation to decrease. Because of socioeconomic development, the demand of (fresh) water will increase by 1.2x to 1.7x in comparison to the baseline 1950-2010. These two directions of future development are opposing und further increase water scarcity and leave more people living in highly water stressed areas, where competition for the scarce resource will become an even more significant problem. The development of tourism and especially higher service hotel facilities further enhances this issue on a local scale.

5. REDUCTION TARGET IN WATER DEMAND

To answer the second specific research question (**What is a desirable reduction target in overall water demand and what is a fair share of reduction effort for the hotel industry?)**, literature has been reviewed and based on the results, a reduction target of water demand has been set.

5.1 Overall water demand

No study exists on how much water will be demanded in the future for the whole of Morocco. Since these data are not available and in order to answer this specific research question, a different approach needs to be undertaken. Based on Rochdane's study (2012) on one specific watershed in Morocco, the water demand until the end of the present century will be estimated for Morocco as a whole. Information on the total water demand per sector exists for one year for the Rheraya watershed as well as projections on unmet demand under proposed adaptation strategies for different scenarios (A2 and B2) in that region (Rochdane et al., 2012). These data will be used to calculate the total water demand for the coming century for this watershed. By comparing the geographic and environmental circumstances of the Rheraya watershed to other areas in Morocco, it can be estimated whether the water demand situation in the future will be approximately the same or completely different in other regions.

Rochdane and her colleagues (2012) calibrated models on the Rheraya watershed, which consists of 224 km² in the High Atlas Mountain with a culmination at the highest summit of North Africa, Jbel Toubkal. In this watershed, water is being used for agriculture (75%), livestock (15%) and for domestic and tourism (10%). Agriculture is by far the largest water consumer in the Rheraya catchment, with tourism as a growing sector only making up one tenth of total water withdrawals. The total water demand in 2012 for agriculture was 15 M m³, for domestic and tourism 3.12 M m³ and for livestock 2.2 M m³ (Rochdane et al., 2012). The overall water demand thus equalled 20.32 M m³ in 2012.

The unmet water demand, defined as the amount of water that cannot physically be delivered to the site where it is demanded, has been calculated for the A2 and B2 scenario (Rochdane et al., 2012; see figure 12 and 13). The A2 scenario is at the upper end of GHG, where CO2 emissions will reach 800ppm in 2100 (Kang & Lu, 2012) intense population growth scenario of 15.1 billion by 2100 (Nakicenovic & Swart, 2000). A2 is also predicting more severe droughts as less precipitation is projected. On the contrary, the B2 scenario is based on medium projection of population growth scenario of 10.4 billion by 2100 and emissions are going to grow, albeit very slowly. Under assumption of the A2 scenario, water demand will increase earlier than in the B2 scenario and unmet water demand will reach almost 9 Mm³ at the end of the century, 1.8 Mm³ of which is projected to be due because of domestic and

water consumption. Under the more optimistic and slower growing B2 scenario, the peak at the end of century lies at around 2.3 M m^3. A dramatic increase in the annual unmet water demand of 70-90% on average in the region is clearly visible (see figure 14).

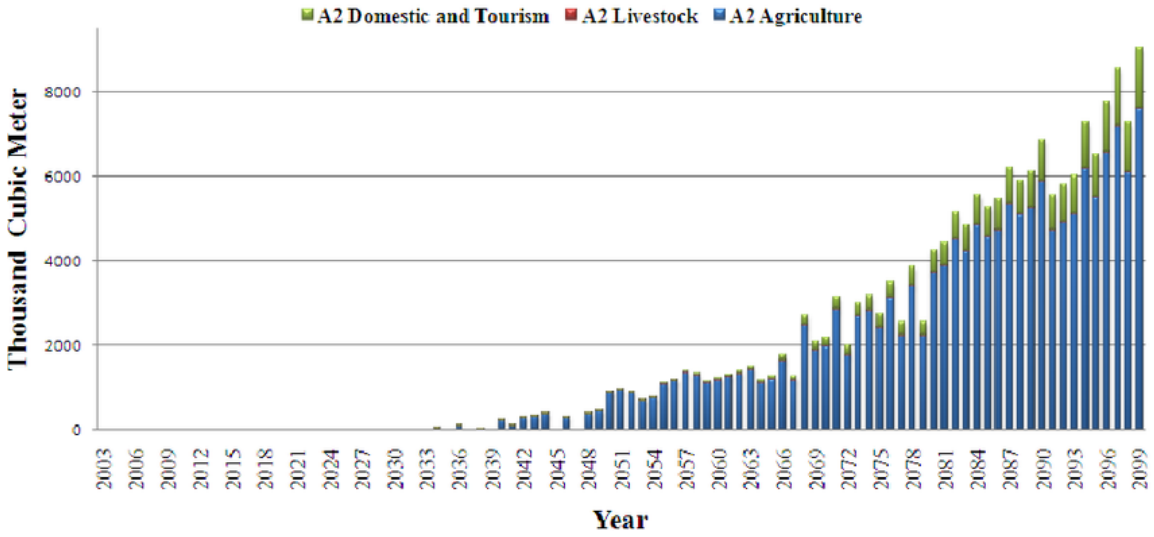

Figure 12. Unmet water demand under the combination of the two proposed adaptation strategies for A2 scenario in a thousand cubic meters.

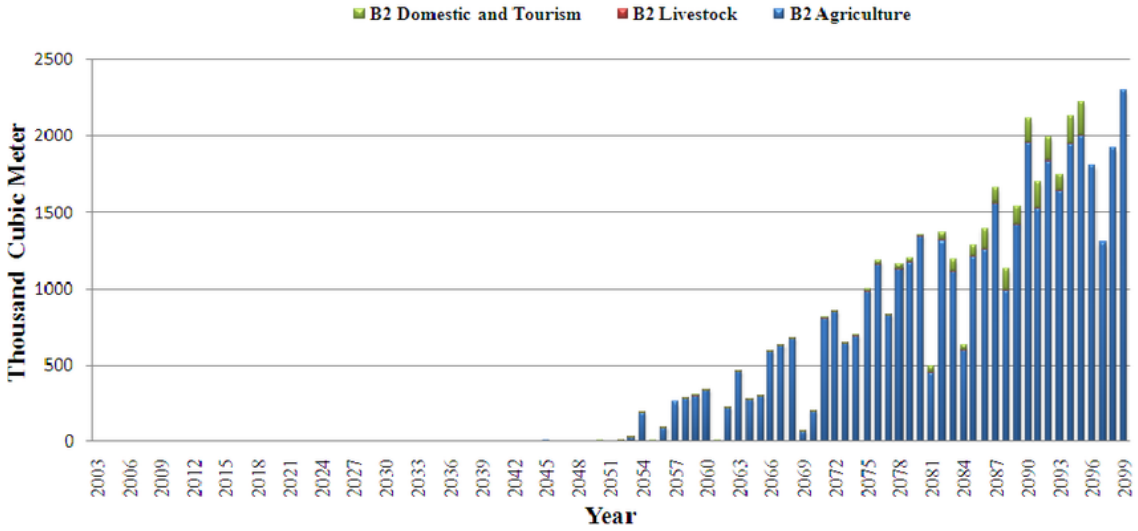

Figure 13. Unmet water demand under the combination of the two proposed adaptation strategies for B2 scenario in a thousand cubic meters.

In 2099, the total water demand for the Rheraya watershed will be 29.32 Mm^3 or 22.62 Mm^3, respectively for the A2 and B2 scenario. However, these numbers do not acknowledge the capacity of water that is still able to be met as it only included the current water demand as well as the unmet water demand in this century. However, since this critical number has been found to be small (see SRQ1), the result will not deviate greatly.

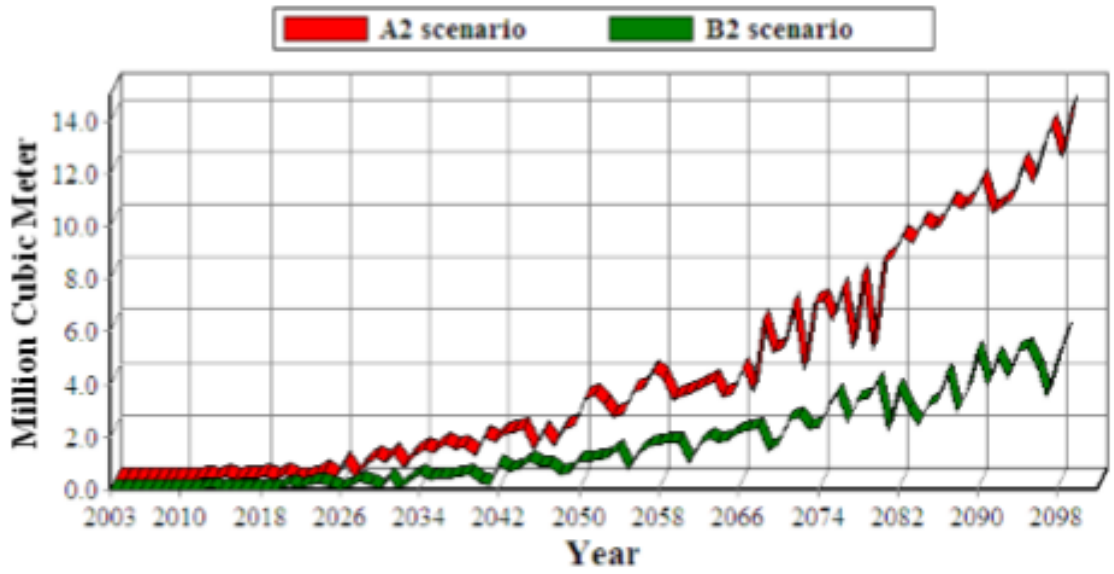

Figure 14. Annual unmet demand for all demand sites.

Based on these results, an estimation can be made towards the future water demand in the whole country. The altitude of the Rheraya basin in the High Atlas Mountains ranges from 1,084 to 4,167m and the variability in precipitation is high with an average of 350mm per year. Despite being geographically located in a distinct environment in the mountains, the region can be representative for Morocco as similarities have been found between this catchment area and other regions. No major city is found in the area, only small-sized cities, population in the Atlas is relatively heavily settled (Barrow & Hicham, 2000). Changes in climate and precipitation do reflect the general changes stated earlier. More intense and prolonged droughts are the main result of the study in the watershed and this is in line with results of other studies in Morocco. However, tourism development is not expected to drastically increase in this region compared to others, which marks a factor that the water demand is likely to get understated. Nonetheless, it can be assumed that these projections for the overall water demand can be used as a representative case for water demand in Morocco as a whole. Since Morocco's landscape is diverse, ranging from more populated coastal areas and less settled desert areas, the results from Rochdane's study (2012) have been found representative as they are balancing out the extremes of changes and climate and socioeconomic development. In spite of that, deviations are possible. Furthermore it has been noted that due to the intertwined nature of tourism, mostly estimates have been used in general to indicate water consumption per guest night.

The Rheraya catchment is composed of 224km² and Morocco covers 446.550km². Under the assumption of similar projected changes then the total water demand for all sectors together would be 58,450.21 Mm³ for the A2 scenario and 45,093.58 Mm³ for the B2 Scenario in 2099. If measured per capita per year, the overall water demand would equal 3.87m³ (population of 15.1 billion) and

4.34m³ (population of 10.4 billion), respectively for A2 and B2 scenario. Per capita per day, the water demand will lie at around 1060 litres (A2 scenario) and 1189 litres (B2 scenario) in 2100. Even though the A2 scenario in general exhibits a more pronounced increase in climatic, economic and technical conditions than B2, the relative water demand per capita under the B2 scenario will be higher on a daily basis.

Compared to the current numbers, the overall water demand for Morocco is projected to increase including the demand of water for all sectors in Morocco as well as domestic use. In order to use water sustainably and to reduce water stress a reduction target in water demand is necessary. Saving water and using renewable water resources will be unavoidable in the future. The target aims at reducing water demand by 40% until 2100. Access to water is a human right and future generations are not supposed to suffer from water scarcity. A lot more people will live in areas facing water stress. Reducing water demand by 40% to mitigate the water balances identified in table 2 lets development under the *business as usual* scenario take place while ensuring water for future generations. This target would result in a reduction of water demand of about 30Mm³, which is a substantial decrease when considering that the current water balance is 40Mm³. However, this target can only be reached when respective policies and effective management measures are being implemented to accordingly control for the water being consumed.

Since tourism in comparison to other industries in Morocco does not greatly contribute to water demand yet, it might be the case in the future as tourism development advances. Especially at the coast and in cities, water demand rises at a higher rate. Tourism can thus be seen as an additional water consumer, whose establishment could foster a constant crisis on the already noticeable water shortage. It has been proven that water consumption per guest night in a hotel can be three times higher than when living at home (Barberán et al., 2013) and therefore, every guest night intensifies water scarcity and takes away water from locals. Water conflicts between different members of society can be the outcome. The only solution to this problem is the reduction of water in every sector including the hotel industry and to implement countermeasures (Tekken & Kropp, 2015). This does not mean that envisaged positive economic effects will be considered less important. Instead, preventing them from being superimposed by environmental issues and associated socioeconomic implications will be more efficient and sustainable in the long-term. Therefore, the limited and steadily decreasing water resources need to be regulated to ensure continuous water supply for all sectors.

5.2 Fair share of reduction effort for hotel industry

As in every other industry, the quantity of water consumed needs to be significantly reduced in tourism and the hotel industry, which is the focus on in this paper. However, since tourism does not account for a great amount of water consumption on national scale (agriculture demands by far the biggest quantity), reductions in the water demand will not be as effective as it might be in other sectors for the overall reduction target. Also, the most significant factor for water scarcity is still the diminishing water supply due to climate change. However, on a local scale it is easier to change water demand than supply as climate change impacts will continue to exert drastic effects on the water availability. Since hotels are the biggest water consumer in tourism and are able to directly make a difference by adapting water effective measures, it is important that they significantly change their current water management towards a more sustainable-based strategy to foster responsible long-term growth and development. Nevertheless the environmental concerns, the hotel still needs to be economically stable and be able to provide customers with a specific level of service. Otherwise the image that tourists have towards Morocco as a tourism destination can significantly change into the negative (Chi & Qu, 2008), which in turn could harm the development of tourism in Morocco. Tourism can be seen as a tool for economic development (Chok, Macbeth & Warren, 2007) and since it has direct responsibility towards water, hotels are not to be neglected for water reduction and adaptation. For Morocco's industry, of which tourism is using approximately 10% of the water being available, it would be fair if hotels are responsible for these 10% of the reduction target stated above. This is a fair share of reduction effort for the hotel industry. Through this number it will be ensured that hotels still meet their economic goals and are being prevented from failing while reducing their WF as well as impact on the environment and society. To achieve this target, hotels need to put sustainability in the foreground and act accordingly. Tekken and Kropp (2015) already recognized the potential of Morocco for successful coastal tourism. They claim that the "environmental carrying capacity should be an integral part of management strategies to avoid the depletion of ecosystem quality and a sectoral failure" (p. 332; Castellani, Sala & Pitea, 2007; Spilanis, Le Tellier & Vayanni, 2012). The risk of business-disruptive water shortages will be lessened as well.

However, it needs to be taken into account that not all hotels demand the same amount of water. As stated earlier, water consumption is mostly dependent on the size of the hotel. This means that bigger hotels and hotels that offer a better service must reduce their consumption more drastically than smaller hotels. This relative distinction should be established in practical guidelines for sustainable environmental management that are to be developed based on the proposed targets. Another fact to consider is the development of the tourism industry. The more hotels are being built and the more

tourists come to visit Morocco, the higher the shared responsibility of the hotel industry. Thus, the reduction target may be adjusted to a higher percentage in several years from now.

6. WATER CONSUMPTION OF HOTELS

In order to answer the third specific research question (**What is the water footprint of the hotels?)**, empirical data on the water consumption of hotels has been collected during the field research in Morocco. The gathered data has been categorized based on the based on the amount of rooms and the service level of the hotels.

In order to answer the SRQ, the water consumption of hotels has been investigated. Eleven accommodation facilities from different cities in Morocco have participated in the study. Five accommodations are in Marrakech (Chems Hotel, The Madrassa, Riad Atlas Marrakech, Riad La Caleche, Dream Kasbah and Kaktus Hostel) two in Meknes (Hotel Tafilalet & Spa, Hotel de Nice) one in Fes (Hotel l'escale), one in Merzouga (Planet Sahara) and one in the desert close to Merzouga (belongs to Planet Sahara). The approximate location of the hotels can be seen in the satellite map below (see figure 15).

Figure 15. Satellite map of Morocco including the location of the accommodations that have participated in this study.

Table 5 shows an overview of the participating hotels and the general information about them and table 6 gives on overview of the water use of the hotels, more specifically the quantity of water consumed as well as the source where the water used is coming from. Most hotels were not able to differentiate between the different types that water is used for in a hotel (e.g. guest room, pool, etc.). According to them, they do not track the water use per type as they only get one bill at the end of the month stating the total water consumed in one month. The numbers in table 6 are for one year.

Table 5. Overview of general hotel information of the hotels that participated.

Hotel	Service level (in stars)	Amount of rooms	Amount of guest nights per year	Swimming pool		Garden		Laundry	
				Existent?	Size of SP (in m^3)	Existent?	Size of garden (in m^2)	Tons of laundry per year	Outsourced?
Chems Hotel	****	154	16240	Yes	Ca. 250	Yes	1260	n.d.	No
The Madrassa	n.a.	5	7300	No	n.a.	No	n.a.	2190kg	No
Riad Atlas	n.a.	4	1950	No	n.a.	No	n.a.	2190kg	No
Riad La Caleche	n.a.	6	3650	Yes	14.4	No	n.a.	2190kg	No
Dream Kasbah	n.a.	9	14600	No	n.a.	No	n.a.	210kg	No
Kaktus Hostel	n.a.	5	9000	No	n.a.	No	n.a.	2190kg	No
Hotel Tafilalet & Spa	****	160	14400	Yes	22.5	Yes	60	110tons	Yes
Hotel de Nice	***	46	6200	No	n.a.	No	n.a.	14400tons	No
Hotel l'escale	****	64	365	No	n.a.	Yes	n.d.	10 tons	Yes

Guesthouse Planet Sahara	n.a.	7	1000	No	n.a.	Yes	2	n.d.	No
Desert camp Planet Sahara	n.a.	3	3000	No	n.a.	No	n.a.	0	n.a.

n.a. = not applicable; n.d. = no data

Table 6. Water consumption and source of water for hotels.

Hotel	Total amount of water used in one year (in m^3)	Water use per guest night (in litres per guest night)	Source of consumed water	Percentage of water that is coming from source
Chems Hotel	21540	1320	Public network	100
The Madrassa	596.8	80	Public network	100
Riad Atlas	346.2	117	Public network	100
Riad La Caleche	567.72	156	Public network	100
Dream Kasbah	1117.8	77	Public network	100
Kaktus Hostel	891.72	99	Public network	100

Hotel Tafilalet & Spa	565	39	Public network	100
Hotel de Nice	303.4	49	Public network	100
Hotel l'escale	900	2466	Public network, Desalinated water & other	n.d.
Guesthouse Planet Sahara	156	156	Public network & Well	85 & 15
Desert camp Planet Sahara	15	5	Well	100

n.d. = no data

6.1 Categories of hotels

Based on the results of the field research, categories can be made to classify the hotels. The categories are mainly dependent on the size of the hotel and their service level.

Category 1: Hotels with higher service level

Category 1 consists of hotels with the highest service level and it includes Chems Hotel in Marrakech, Hotel Tafilalet & Spa in Meknes and Hotel l'escale in Fes. All of the hotels have a garden, but only the first two have a pool. While all of them are located in the city centre, Chems Hotel has its very own ground in between the new and the old city centre, allowing it to expand. The other two hotels are restricted in that sense by surrounded buildings and streets.

Category 2: Hostels with dorm rooms and Riads

This category includes The Madrassa, Riad Atlas, Riad La Caleche, Dream Kasbah, Kaktus Hostel and Hotel de Nice. These types of accommodation are characterised by less rooms, bunk beds and shared sanitation facilities although the three-star Hotel de Nice is a typical hotel with private rooms instead of dorms. None of them does have an adjacent restaurant, however, they do have a kitchenette for the guests to cook for themselves. The hostels and Riads usually do not have their own ground. Instead, they are relatively small-scaled and the hostel or Riad is integrated in other buildings, which limits their size although it allows them close proximity to city centres and/or medinas.

Category 3: Desert accommodation

This is an extra category. Accommodation facilities in the desert are different to the ones in cities, as they usually have few rooms and put more value on the guest's experience. Almost every accommodation in the region offers trips into the desert, thus guests often combine these two. This is also the case for the Guesthouse Planet Sahara in Merzouga, who offer camel treks and overnight staying in the desert camp in between the sand dunes. However, the guesthouse was in the renovating phase when the field research took place, thus not as many rooms were fully booked. In general, about 3000 people stay in the camp in the desert every year. The 'rooms' are technically no real rooms as they only include mattresses that can be taken out to sleep outside under the stars.

6.2 Results of the hotel's water situation

Due to the diversity of types of accommodation, the results can partly hardly be internally compared to each other. Hotels with a higher service level have more rooms and more guest nights per year than smaller hotels, Riads or even the camp in the desert. More customers result in more laundry and in turn in a higher water consumption rate. Stark differences can also exist even within same-level hotels and within categories.

Category 1: Hotels with higher service level

On average, the three four-star hotels in this category are having 126 rooms, 10335 guest nights per year and a water consumption of 7668m³ per year. The latter number is a really rough average because Chems Hotel is using more than 40 times as much water as Hotel Tafilalet & Spa. On average, 742 litres are being consumed per guest per night. The three hotels are all sourcing their water from a public network. Additionally, Hotel l'escale makes use of desalinated water as well as water from a well.
Moreover, Hotel l'escale indicated the water quantities per type: Out of the 900m³ of water used in one year, 240m³ are being used in the guestrooms (including shower, toilet and sink), 540m³ for the kitchen and 120m³ for laundry. The high amount of water being used in the kitchen is due to the fact that the hotel is located on the main street in the new city in Fes and that the restaurant is public. Thus, people passing by the hotel are also able to enjoy the amenities of the hotel even though they are not registered as guests staying overnight in the hotel.

Category 2: Hostels with dorm rooms and Riads

The six hostels and Riads in this category have on average of 13 (dorm) rooms, 7117 guest nights per year and are consuming 470.1m³ of water per year, which results in about 66 litres per guest per night. While the five hostels and Riads have similar characteristics, the three-star Hotel de Nice has a lot more rooms although similar quantity of guest nights. This hotel does not have dorm rooms, instead it has more single and double room bedrooms. Hotel de Nice stands also out as the amount of laundry is relatively high compared to the other accommodations in this category. Also, this is the only accommodation in this category where water is coming from a public network/municipality instead of a well. The hostels are often completely booked out resulting in a high water demand. As in the first category, data per type of the hotel have been gathered as well. Hotel de Nice indicated how much water they are using in more detail. From the total water quantity of 303.4m³, 105.4m³ are being consumed in the guest room, 80m³ in the kitchen and 100m³ for the laundry. 18m³ have been classified as 'other'.

Furthermore, it was possible to gather data on the monthly water quantity data from four of the hostels and Riads, namely Riad Atlas, Riad La Caleche, Dream Kasbah and Kaktus Hostel (see appendix D, E, F and G, respectively for Riad Atlas, Riad La Caleche, Dream Kasbah and Kaktus Hostel). The diagrams indicate a higher water demand in the summer months as well in the winter. In Riad Atlas and Dream Kasbah, the highest water demand has been measured in September, whereas July is the month with the highest demand in Riad La Caleche and October in Kaktus Hostel. Usually the lowest water quantities have been recorded in spring from February to May. In two of the accommodations the water demand dropped drastically in November, whereas in Road La Caleche and Kaktus Hostel the demand was higher than the average. Furthermore, the biggest variance between the months is evident in Dream Kasbah with less than 20m³ measured in May and more than 40m³ measured in the September. In contrary, September marks the months with the lowest water demand for Riad La Caleche, while in July a water demand of about 150m³ has been recorded. These results from the monthly analysis reveal that there is no consistent pattern and high inter-annual water demand are indisputable.

Category 3: Desert accommodation

Around 1000 people stay in the Guesthouse Planet Sahara every year. Each of the seven rooms include a bathroom and public showers and toilets exist for the guests who are returning from the Desert Camp. In total, 156m³ of water is being used every year, which equals 156 litres per guest night. Out of the total amount of water being used, 85% comes from the public network and 15% from the well. The water coming from the public network is delivered to Merzouga via a pipe from the neighbouring city (El Rachidia) where wastewater gets cleaned and delivered back to Merzouga. This water is being used for guestrooms as well as public sanitation facilities, cooking and to feed the camels. The water from the well is mainly used to water the small garden and plants as well as for maintenance work, which was the case during the field research period.

The desert camp, which includes around 12 mattresses, uses a tank for the toilet as well as for irrigation purposes and to use it as cooking water. This amount is relatively little compared to other types of accommodation. The tank, which carries about 1000 litres lasts for approximately 3-4 weeks according to the camp owner. Its gets refilled 15 times a year, meaning that the water usage is about 15000 litres a year and 5 litres per guest night. Then the tank gets refilled again. Hygienic standards are low and the sanitation facilities are not even being used all the time. The water that is being used comes from the well back at the Guesthouse. This water is salted and cannot be used as drinking water. Guests need to bring their own water to the desert camp and staff brings water for the camels to drink as well.

These results show that the water consumption varies substantially for different types of accommodation. On average, the water consumption of all hotels that have participated in this study lies at around 2250m³ per guest night per year. Since 7064 guest nights per year on average (77705 in total) have been recorded, this means that 0,31m³ of water is being used on average for every guest night in the hotels that participated in the study. This equals 310 litres per guest night on average compared to 742 litres for high service level hotels, 66 litres for hostels and Riads, 156 litres in the guesthouse in the desert and 5 litres in the desert camp.

7. ADAPTATION STRATEGIES FOR HOTELS

The last specific research question SRQ4 (**Given the hotels water consumption, what are possible adaptation strategies to meet the reduction target for hotels?)** has been answered through the reviewed literature and the analysis of the answered SRQ's. Adaptation strategies will be developed based on the calculations of the water consumption and the set reduction targets.

Water conservation is a hot topic in today's society, especially in an era of climate change. Hotels can strategically better adapt to future water scarcity issues on different scales. On the one hand, hotels are able to make direct decisions affecting the water consumption in their hotels themselves. Through regulating the water flow, raising awareness among hotel visitors and implementing more efficient water technologies or reusing of water, hotels have many options to directly take action. On the other hand, the hotel managers in a given area can collaborate to collaboratively commit to higher environmental standards. The government as another crucial player in water management is able to have an influence on hotel's water use by implementing environmental policies and standards. They are also culpable of the distribution of water among other industries.

7.1 Water reduction measurements in hotels

In a hotel, measurements can be taken to drastically reduce the WF of the hotel. Regarding the direct WF, the goal is to either reduce water consumption or to use the water more efficiently, meaning that the water should get recycled. First of all, the hotel should strive towards full water recycling in order to cut down the blue WF as low as possible. This can additionally be achieved through more precise irrigation techniques. The grey WF can be cut either by fully recycling materials and heat or by organic farming. Additionally, through making rainwater more productive and increase the quantity of rainwater being harvested, the green WF can be significantly be lowered.
In order to achieve the reduction of the WF, hotels need to know how much water they are currently using. The field research revealed that most hotels, mostly the smaller ones, do not track their water usage. By installing meters and submeters hotels are able to take readings of the consumption and respectively, identify areas of greater water usage. If the water use is known, then the hotels can set feasible targets. To achieve the target and thus, increase the hotels efficiency, hotels have to change their operational use. Therefore, they should adopt the following practical adaptation strategies:

7.1.1 Guest rooms

In the guest room, which accounts for the highest water use within the hotel, water can be saved for the toilet, shower and sink. When brushing teeth or washing hands, the tap of the sink should always

be turned off when not in use. Imperative for increasing the customer's environmental awareness and stimulate them to act responsible, signs should be used to indicate the amount of water used for instance one shower (see appendix H for an example). Studies have shown that the signs in combination with comparisons to what the used water could have been used for otherwise has a significant influence on the customer's behaviour (Schultz, Khazian & Zaleski, 2008). The flow of the shower should be reduced to a maximum of 7 litres per minute (Styles, Schoenberger & Galvez-Martos, 2015). Devices exist to reduce the shower flow by regulating the water pressure. Measurement of the shower flow is easily applied by using a bucket and a stopwatch. Toilets should also get equipped with a low flush of about 6 litres per flush. If this option is too cost-intensive or not feasible because of other reasons, then a simple alternative is to put a water bottle filled with water in the cistern of the toilet, which displaces water and thus, less water will be used per flush. Highly important for all facilities is continuous maintenance. If facilities leak water, it can cost a lot of water, for instance 750 litres per day for a leaking toilet (Green Hotelier, 2013). Styles et al. (2015) calculated that on an annual basis, 4344m³ water can be saved in a 100-room hotel when optimizing performance in the guest room.

7.1.2 Swimming Pool

As for the swimming pool, regular maintenance checks are from high importance. Furthermore, backwashing should take place only every two to three days instead of every day. If backwashing is done for one minute less (4 minutes instead of 5 minutes) every two to three days, then 496m³ of water can be saved for a 100-room hotel annually (Styles et al., 2015). A system should be chosen which allows the pool water to get recaptured so that it can be used for irrigation purposes. Covering the pool's surface prevents water from evaporation. According to Styles and his colleagues (2015), 119m³ water can be saved annually when the performance of pool evaporation is optimized. Thus, when the pool is not in use, it should be covered, which also reduces the need to empty and refill the pool. Also, it should be thought about the necessity of having a swimming pool as it increases water demand by around 10%.

7.1.3 Garden

With regard to irrigation, automated watering systems should be avoided. Instead, a controlled system should be considered that will only distribute water when it is needed. By installing sensors that measure the moisture in the soil, this information can get delivered to the sprinkler and hence, over-watering will be avoided. The best time to water grounds is in the evening, as the temperature is much higher during the day and more water would evaporate then due to the heat. When plants and gardens are still getting watered by hand, then the staff should be trained accordingly to only use

water where it is needed. Another option to save water in the garden is to use grey water from the guestrooms and public toilets to irrigate. However, a better option is to use rainwater. The harvested rainwater from roofs and gutters can be stored in underground tanks for instance. Also, endemic species should be held in the garden as they have adapted to the regional climate conditions and often need less water than plants from other environments. Organic compost from the kitchen of the hotel can be used to help retain the moisture in the soil and to add nutrients.

7.1.4 Laundry

First of all, when buying a laundry machine it should be ensured that the rating is eco-certified for the water and energy consumption. Independent of the size of the hotel, the laundry should always be fully loaded. To reduce water one option is to wash smaller quantities in a smaller machine. The rinse cycle should be kept to a minimum. Hotels with more than 500 beds can opt for installation of a continuous batch washer, through which makes use of the rinse water used for pre-washing. Also, this water can also be reused for the next rinse cycle by installing temporary holding tanks (Green Hotelier, 2013). Moreover, the hotel should implement policies for the guests to let them choose whether they want to reuse their linen or having it changed daily. The linen reuse strategy is most successful when the choice is given to the guest.

7.1.5 Kitchen

A lot of water can be saved indirectly by only offering products that have a low Water Foodprint and are in season. Nonetheless, water can also be saved directly in the kitchen. Dishwasher should only be used if they are fully loaded and the taps should not have a higher flow than 10 litres per minute. Running water should in general be avoided. Dishes should be pre-soaked and vegetables washed in sink filled with water. Ice machines should be minimized. With regard to the indirect WF, food plays a crucial role.

Adopting these suggested strategies, the hotel may highly benefit from it can get environmental certificates and/or labels, which can, scientifically proven, increase the amount of visitors choosing this hotel (Segarra-Oña, Peiró-Signes, Verma & Miret-Pastor, 2012). More tourists are choosing their accommodation based on the environmental impact and how ‘green’ it operates. Thus, the respective accommodation will be more successful and making profit is the main goal for every hotel. Furthermore, the image of the tourism industry in Morocco can therefore be significantly increased as well if more accommodations are certified as environmentally friendly and sustainable.

Likewise, the target set is closer to reach if these practical strategies will be carried out. The 10% reduction of water consumption in the Moroccan hotel industry is feasible and already reachable by adhering to these proposed recommendations on how to increase water efficiency.

7.2 (Sustainable) Water management

Besides directly reducing the hotel's water consumption and reducing the operational WF, hotels should establish sustainable water management. Hotels should develop a water management plan. The field research has shown that not a lot of hotels track their water consumption and are aware of the water quantity they are using and how that can affect and can be affected in the future. Therefore, a plan should be established on how to increase the awareness and reduce the hotel's WF. The ITP claims that in order to set up a plan, hotels need to start measuring their water use and set feasible targets (Green Hotelier, 2013).

Through holding on to the water management plan, hotels can become certified. This should be the aim of every hotel. Hotels should collaboratively commit to high level environmental standards to tackle the projected changes of water shortages (Tekken & Kropp, 2015). Through certification or labels, information about the water situation and the commitment of the hotel will be more present in the hotels. Hotels have a responsibility in educating employees, stakeholders, guests and the local community. Key for this is communication. Hotels in particular influence attitudes ad practices of guests and through communicating their sustainable commitment to the customer, guests can reflect on their own water use at home and when travelling. For the overall reduction in water demand, education and communication is a key component. In water scarce areas like Morocco another options for hotel to contribute to water saving is to include guests and the local community to learn about regional water issues and to raise their environmental awareness. Even though these educating tours do not actively reduce water use, it is a crucial step in long-term sustainable water management.

Other options how hotels can better cope with water shortages is to manage the water situation accordingly. They should make use of more desalinated water and reuse and recycle more wastewater (Seif-Ennasr et al., 2016). Furthermore, hotels should cooperate with their suppliers in order to reduce their supply-chain WF. Hotels are powerful players with a lot of choices. They can choose their suppliers and eventually change to another more efficient and sustainable supplier with a lower water use. In order to do so, product transparency from businesses are essential. Sustainable products should be chosen and consumption patterns can be changed as well to lower the water use.

7.3 Governance arrangements for sustainable water management

The government should be incorporated in the sustainable water management of hotels as well. They should be responsible for setting restrictive regulations and standards. The targets set in this paper should be taken on in their water management plans to not exceed water thresholds. Additionally, the assessment of hotel's water consumption and/or the WF should be embedded in the national water policy making resulting in a strengthened environmental framework to protect natural resources (del Mar Alonso-Almeida, 2012). Other practices on the governmental scale include the promotion of coherence between water and other policies and to advocate more transparency. To stimulate the hotels to reduce their water consumption, not only should be more invested in water saving technologies, but also a water tax for luxury accommodations should be implemented as they are the main water consumer in the tourism industry. Sustainable commitment will be ensured through this (Tekken & Kropp, 2015). Furthermore, partnerships between hotels should be encouraged. This increased capacity Morocco can adapt a new marketing strategy in order to become a unique tourism destination that is based on sustainability. Seif-Ennasr and his colleagues (2016) also highlights the importance of public-private partnerships as they are a good indicator of the awareness that hotel staff and other stakeholder have towards saving water and acting against water scarcity.

8. DISCUSSION

In this study climate change impacts in Morocco and options for hotels to adapt to future water scarcity have been investigated. In this chapter, the main findings will be elaborated on based on existing literature. The main research question has been answered based on the results of the specific research questions.

8.1 Climate change impacts on the hotel industry in Morocco

One of the most significant findings of this study is the drastic decrease in water availability in the near future. Climate change is highly impacting water supply, making Morocco one of the most vulnerable regions worldwide. Due to both the diminishing water supply and the rising water demand, water shortages already constitute a major challenge for Morocco. This will become even worse in the future with drastic changes in temperature and precipitation. The results of SRQ1 revealed an increase in temperature of at least 2°C and up to 5°C in summer months and a decrease in precipitation of 20-40%. These results of Giorgi and Lionello (2008) are generally consistent with previous studies using different and same climate change scenarios and models (Giorgi & Bi, 2005). Giorgi and Lionello conducted a more comprehensive study than García-Ruiz et al. (2011), including projections until 2100. The projections until 2100 from the IPCC, forecast that precipitation will be reduced by 40-60% in Morocco, which is 20% more than what Giorgi and Lionello (2008) identified. All the findings commonly reveal that forecasts for Morocco are more pessimistic in terms of water availability than for other parts in the Mediterranean. This supports several scientific existent papers arguing that Morocco is one of the most vulnerable regions on earth to climate change (Christenson et al., 2007; Gössling et al., 2012).

As a result of the increasing water scarcity, competition for resources will be higher. Morocco is investing in tourism as the engine of future economic growth, yet, the industry adds a considerable amount of water needs. This tension between tourism development and water scarcity is massive and because of the high ambitions of the Moroccan government with regard to tourism development, a radical rethinking is essential to cope with the changes and to ensure water availability. An important conclusion from the findings is that on a local scale it is easier to change water demand than water supply. By implementing the options proposed water consumption can be radically reduced. The impact of climate change is one that is more difficult to cope with.

8.2 Water demand

Hotels have a responsibility towards the environment and the local communities. The coincidence of climate change and socioeconomic development particularly challenges the management of water resources in a hotel (Seif-Ennasr et al., 2016). With regard to the projected tourism development and to keep up the positive image of tourism in Morocco, hotels have a high responsibility to be as 'green' as possible. Since a lot of attention is already paid to Morocco due to the COP22 held in Marrakech in 2016, this focus should be taken on to stimulate the hotel industry to further raise awareness about local water scarcity issues. Even though it is often stated that Morocco's tourism industry has the potential to be a leader in sustainable development, the practical implementation of water reduction options is lacking and often, these intentions are not being translated into reality. This is also the case for the future vision on tourism. The ambitious tourism development plan *Vision 2020* of the Ministry for Tourism has been set too high according to existent literature. It is not feasible to reach 20 million tourists by 2020, instead Gössling et al. (2012) estimate 15.2 million tourists to arrive in 2020. Even this number is quite optimistic as 10.3 million tourists visited Morocco in 2016. Hence, the government of Morocco needs to set more realistic targets that are achievable. The proposed strategies on sustainable water management and governance arrangements are only feasible if the government prioritizes the conservation of natural resources. Currently, their implication is still limited due to the lack of political will, which has also been identified by Tekken and Kropp (2015). This dilemma between Morocco as a pioneer in sustainable water management and the laxity of the handling of their water resouces has been discussed in existing literature.

8.3 Tourism water consumption

The findings of the water demand analysis for this century confirmed that tourism development is not the main water consumption industry, which is uniform with existent literature. Agriculture demands by far the highest water quantities and the influence of tourism development is minimal (AccorHotels, 2016; Hadjikakou et al., 2013; Rochdane et al., 2012). The demand in the area around Marrakech and other tourism centres like Fes and Meknes will 'only' increase by 1.2x even though tourism is projected to rise tremendously. This relative growth in water demand compared to other regions is also due to the higher water efficiency measures and options taken on to reduce water consumption in the hotel industry, which is the main direct water consumer in tourism. However, on the coast tourism development will have a much greater impact on the regional water situation, which is consistent with studies conducted in coastal areas in Morocco (Tekken & Kropp, 2015). Due to the established *Plan Azur* new resorts are being built along the coastline. Since luxury hotels have been identified to use a

higher amount of water compared to small-scale accommodations, the construction of these additional resorts will have a more drastic impact on the water situation, in particular on a local level.

Even though the results for SRQ3 have varied, the overall average of field research data fits well with current literature. It has been argued that the average water consumption per guest night for a three-star accommodation in Morocco lies at around 300 litres (del Mar Alonso-Almeida, 2012 & Eurostat, 2009). The calculated average for higher service level accommodation from the field research, which consisted of all types of accommodation ranging from hostels to four-star hotels with pool and gardens is slightly higher than the numbers provided by del Mar Alonso-Almeida (2012) and Eurostat (2009), and the water quantities calculated for hostels are relatively low. However, the latter is due to the amount of dorms. Dorm rooms are usually quite small and can host up to 20 guests (in some hostels even more). However, mostly only one bathroom exists per dorm which limits the time every guest can spend in the bathroom. Also, hostels usually do not have a pool, garden and kitchen, which already drastically reduces the water consumption compared to other types of accommodation. The average of 66 litres per guest night can therefore be added to the data provided by del Mar Alonso-Almeida and Eurostat. Thus, this study expands current existing literature. Another reason for the low water consumption rate of the hostels is the location. All of the hostels in that category (besides Hotel de Nice) were located in Marrakech, which has been argued to be one of the main tourist hotspots in Morocco. High demand for tourist accommodation results in high competition.

Chems Hotel in Marrakech and Hotel Tafilalet & Spa in Meknes, both four-star hotels, have almost the same capacity of rooms as Chems Hotel, whicg has a slightly higher number of guest nights per year though. Despite these similar characteristics Chems Hotel's water consumption is almost 40 times higher than the one from Hotel Tafilalet & Spa. This difference can partly be explained through the bigger pool and garden. However, it can be questioned whether the data obtained are correct as the difference is intense. Eventually, water leakages may be a reason for the high water consumption rate, which would drastically increase the water consumption. This case shows how important it is to analyse every hotel on its own and examine regional climatic, geographical and socio-economic circumstances.

Two hotels, namely Hotel de Nice and Hotel l'escale, indicated where exactly the water is being used for in the accommodation. While by far the guestroom consumes the biggest share of the overall water use, this part is taken over by the kitchen in Hotel l'escale. However, the latter case is contradicting with general information about water consumption in hotels. According to Green Hotelier (2013), only 15-25% of overall water demand is generally being consumed in the kitchen, whereas the guestrooms usually accounts for 40-50%. Additionally, Hotel l'escale does not have a lot

of guest nights per year compared to other hotels and accordingly, less laundry. This confirms that the adjacent restaurant is not only open to guests but also to other visitors. This has been noticed during the field research, when I as a visitor and not as a guest staying overnight was able to consume food and beverages.

Furthermore, seasonal differences in water consumption have been discovered in this study. As has been found in South Africa and Barbados, the water demand is highest in summer months (Charara et al., 2011; Rankin & Rousseau, 2006). Even though this is also the case for most of the small-scale accommodations in Morocco, in particular Marrakech, inter-annual variability is high and the water demand fluctuates drastically. In general, water uses are high in winter months around Christmas as well. This reveals that tourists are visiting the city all year round in high numbers. However, this may be different in other areas in Morocco, as a big share of tourists to the Atlantic coast for example comes in summer. High and low season are thus differing per region.

8.4 Options for hotels to adapt to water scarcity

All of the four SRQ's have helped to answer the main research question (**What options do hotels in Morocco have to adapt to the region's projected changes in water scarcity?**). Hotels in Morocco have many different options to adapt to the region's projected changes towards water scarcity despite a relatively pessimistic forecast forcing drastic changes to be made. As a result of socioeconomic development and growth, water resources rise in demand and in turn, resource competition will increase. Consequently, sustainable options need to be considered to avoid overexploitation and water crises. Every hotel as representatives of the tourism sector in Morocco should aim to reach the proposed target in reducing water demand by 10% so that the overall goal of cutting the water demand by 40% can be achieved. However, to effectively offset the effects of climate change and socioeconomic development, the reduction goals actually needs to be higher than the proposed 40%. However, a target higher than this is not feasible and not realistic. Small steps are more pivotal. The study by Seif-Ennasr and his colleagues (2016) revealed that under the most pessimistic climate change scenario, the water balance will be as high as -132.2 Mm^3 alone in the Chtouka aquifer in 2030-2050. The actual reduction target should therefore be set higher to balance out the changes in water supply and water demand. As has been shown in the literature only 971m^3 per capita per year are potential total usable water resources in Morocco (see table 3), which is relatively low compared to Spain with 2794m^3 per capita. However, realistically seen a higher reduction target than 40% is not possible. By comparing the water demand findings from the Rheraya watershed (Rochdane et al., 2012) to the water balance data in table 2, it is evident that the water demand calculated for 2099 will by far outstrip the amount of water being available. This will probably be already reached in the middle

of the century. Reducing the water demand by 40% from 58,450.21Mm³ and 45,093.58Mm³ (respectively for A2 and B2 scenario) to 23,380.08Mm³ and 18,037.432Mm³ means approximately 30Mm³ less water being demanded in 2099. However, since the water balance is already in the negative and projected to triple under the most pessimistic scenario (table 2), water demand should be as much lowered as possible. Morocco is still in the learning phase and even though many water reductions options in hotels have been implemented, it was not consistent throughout all hotels in Morocco. This reflects the identified lack of will and urge. Consequently, it is more rational to set a realistic target which can be reached. Otherwise, other services would suffer and growing inequities can lead to national conflicts about water use.

Moreover, during the field research phase it has been noticed that locals may over- or underestimate the degree of environmental degradation, which has already been found by Barrow and Hicham in 2000. Therefore, an objective benchmark necessary for the whole industry. Some areas and communities are more affected by climate change impacts and the increasing water demand than others, which needs to be taken into account.

Several options for hotels exist to cope with future water scarcity and to reduce their own WF by lowering the consumption of fresh water. These options have been presented in SRQ4. Many hotels worldwide have already adopted some of these options proposed and even in Morocco proof has been recorded to try to reduce the water consumption and to raise awareness within the hotel (see Appendix H). For instance, water management initiatives have been found to be successful in European countries, where high efficiency of water resources result in a consumption just over 200 litres per guest night (Hamele & Eckhardt, 2006). Even though environmental sustainability is rising within the tourism sector the growing awareness has not yet fully translated into according actions and behaviours. Despite attempts to mitigate adverse impacts as much as possible by implementing water saving measures, tourism-related water use is rising. Even though the focus in this study was on the direct water consumption, indirect water use should be decreased as well. It has been argued that a lot of water is incorporated in food production for instance (Gössling, 2015). However, some options might be cost-intensive or implementing them takes time. This is the reason why it is important to implement the proposed options as soon as possible. By 2040, which is in a bit more than 20 years from now, water availability will have decreased by almost 2% around Morocco.

Therefore, it is pivotal to put more focus on renewable water resources as well as desalination as a viable option keep up with the rising demand while groundwater reservoirs are shrinking. Gössling et al. (2012), who have diagnosed Morocco as a “tourism country that will be chronically short of water by 2050” (p.7), found that a big share of Morocco’s renewable water resources are already used for

tourism. Yet, more renewable water should be made use of in general across all sectors. Moreover, even though desalination plants are energy-intensive and expensive, they are seen as viable means to boost the supply of freshwater (Burger, 2014). Through pre-treatment filtration and advanced reverse osmosis, 100,000m³ of potable water will be produced for daily consumption (see Appendix I for visualization of the process). The project plan of Abengoa to construct what will be Morocco's largest desalination plant in Agadir, a rapidly growing tourism town at the Atlantic coast, shows the critical water situation and that the government takes first steps to address the water challenge. This option to increase the amount of freshwater shows that the government is willing to invest in costly options. While it makes more sense to implement desalination plants in tourism hotspots at the coast, the use of renewable water resources from natural underground freshwater should be considered in the mountainous region of Morocco. Different options might be best for different regions.
It is crucial to take action now and to guide the hotels to more sustainable operation practices. Most importantly, hotels need establish appropriate measurement tools and a water management plan as not every hotel is keeping records of their water consumption at the moment.

8.5 Limitations

This research was restricted by some limitations. It was limited in that not all of the relevant information needed to answer the research questions and for the calculations of the WF have been obtained. Gathering data in Morocco is difficult and efforts to mitigate shortcomings by using other sources was needed. This may result in deviations from the actual value.

Another issue regarding the data collection is the language barrier. This already limited the first phase of the research, when literature had been reviewed. Throughout the desk research, only English literature has been reviewed. However, studies in Arab or French might exist that have not appeared to me and are inaccessible. I do not speak Arab or French, and the target groups during the field research in Morocco mostly did not speak English fluently. The English level of the target groups and participants often was low, which complicated communications. Because of that, a translator was in some cases unavoidable. Even though communications have been eased through the use of a translator, information might have gotten lost in translation. Also, it is not ensured that all of the information I wanted the translator to pass on to the participant have been translated correctly. Therefore, there is a chance that certain information have been misinterpreted by the participant, the translator or me. Since the translator and the participant were from the same community, the translator might furthermore be influenced and did not feel secure to share certain information.

Before the data collection in Morocco, potential hotels from international hotel chains have been contacted via email and phone to inform them about the research and ask for willingness to collaborate. In this period more than a hundred hotels have been approached. In every contacted hotel, appointments with hotel managers or responsible managers from the technical department were unable to be made as the hotels demanded more information about the study before appointments were to be taken. However, after sending them the relevant information via email and doing follow-ups via phone, no responses have been recorded. Most hotels did not get back to me or were unable or not allowed to share the data needed with me. This was also the same when I sent out the designed questionnaire to hotels via email. Email addresses from hotel and potential participants have been collected through the internet and the hotel's websites. The online questionnaire has been sent via email to more than a hundred hotels around Morocco. The target group were hotels with a higher service level, meaning hotels with four and five star ratings. However, not a single response has been recorded as well.

Even though this technical obstacle slowed down the data collection, the results are still relevant. A different approach has been drawn upon and adapted to the circumstances on-site. Instead of electronical contact, the participants have been approached personally by showing up in the hotels. This methodological change might even have significantly strengthened the study as the consequent informal interviews that took place gave more insight into the water situation of the hotel than online questionnaire would have (for instance the differences in water consumption per month). Face-to-face communication allowed for more meaningful conservations. On the other hand, this change limited the research in a way that less responses from luxury hotels have been collected. Especially the target persons in international hotel chains were extremely busy and mostly not even present in the hotel. Attempts to schedule appointments in advance have not been successful as they barely answered my phone requests. Additionally, luxury hotels always asked for financial compensation. Despite collecting less data on higher service accommodations, it was therefore possible to include a larger variety of hotels in Morocco in the study, which allowed for comparisons between different types of accommodations. Hence, initial research plans have been adapted during the field research phase in Morocco and additional, meaningful and substantial data were able to be obtained.
This however, leads to limited representativeness. Since only eleven hotels with completely different types of accommodation participated in the study, this research underlies confined representativeness for Morocco as a whole and due to the diverse landscapes of Morocco, the results cannot be generalized for every region.

8.6 Ethics

Since this study is partly based on qualitative research and consequently engagement with participants, it must be ensured that the participants are protected from psychological, emotional and physical harm (De Vaus, 2001). Ethical and moral issues must be considered when conducting qualitative research in order to avoid any distress (Antwi & Hamza, 2015). Morocco is a Muslim country, thus modest and conservative clothing is appropriate to wear to show respect.

When potential participants have been approached, I introduced myself, the academic institutions (Wageningen University and Research and NHTV University of Applied Sciences Breda) and the purpose of the study. Thus, the participants have been familiarised with the research before they were asked to participate. During the informal interviews, it has been ensured that the participants are aware of their rights and that they are participating on a voluntary basis and they are able to withdraw at any time (Smith, 2003). However, this was often challenging as conservations often started off with a different topic, out of which the participation and the filling in of the questionnaire resulted. Nonetheless, all of the participants have agreed that the gathered information can be presented in this report.

Since all of the questionnaires have been filled out by hand, it was not possible to force responses. The participants were able to skip questions which they did not feel secure about answering or which they do not know the answer to. Moreover, the questionnaires have mostly been filled out during the informal interviews. Participants might have felt pressured by the presence of me as the researcher. Even though I clarified that they should only answer the questions they know, there is a chance that they just wrote down estimations of their water consumption. Also, it could be that these information might not be exact because an extremely high water consumption rate could reveal leakages or other inconveniences, which they would probably not feel confident talking about and might lead them to feel disadvantaged. To prevent these situations I calculated the water consumption based on the monthly bills together with the participants. All of the participants who did not measure their water consumption themselves let me have a look on their water bills without hesitation. They were not sceptical about sharing the data with me at all and I assured confidentiality and that the information obtained are not being distributed to third parties and only serve the purpose of this study.

The informal interviews held are subject to bias as I have been engaged in social activities with some participants. Through the personal involvement the division between the researcher and the participants has been minimised. However, focusing on specific topics allowed me to stay objective.

While personal connections with some of the participants and the translator might have slightly influenced the selection of the hotels, these connections also helped to spread the purpose of my study, also to locals who would, due to the language barrier, not be aware of it. After the study, the results will be sent to these connections as they are willing and have agreed to share the results of this study and the adaptation strategies with the hotels that participated. This is crucial in order to raise awareness about climate change impacts, meaning that this study has the potential to educate, share knowledge and to make an impact.

Another ethical dilemma is based on the background of the participants and me as the researcher. Since I was raised in a fundamentally different environment than the one of the participants, differences in understanding, perception and interpretation might be the result. For instance, some of the Moroccan target persons I talked to did not see the urge of climate change adaptation to water shortages. After telling them how temperature and precipitation will change in the future, they bespoke that these changes are little and that the communities are easily able to adapt, if adaptation is necessary at all. Additionally, in Morocco face-to-face communication is common and as has been observed during the field research, technical devices are not widely used for these purposes.
Other cultural differences complicated the research as well. For example, while I was always on time for appointments, most of the participants did not take the time too seriously. Thus, it happened once that I was waiting for almost six hours instead of the initially proposed ten minutes and eventually, the target person did not even show up. Dependency on local actors was also problematic for the end of the data collection phase, when I was about to leave the country and still about to receive data.

8.7 Scholarly relevance

This study resulted in contributions to both the social and academic field. First, the case study showed how much water is needed to sustain a hotel in Morocco. The findings unveiled possibilities to adapt to future changes in climate and consequently and to the amount of water that will be available for the tourism industry to use. This research further provided new insights into the academic importance of the water consumption in tourism and therefore addresses the gap in combining these information with options to counteract or withstand the effects of the changes of water demand and supply in the hotel industry. It further contributes to the academic literature by assessing the local implications of (sustainable) environmental management of hotels, which is a crucial component in tourism and has often been neglected. The study thus gives insight into practical recommendations for the hotel sector, which have been forwarded to the hotels that participated to stimulate their environmental awareness and if implemented, ensure a reduction of their water consumption.

9. CONCLUSION

This research has examined how Moroccan hotels can better adapt to future water scarcity by assessing both the degree to which the water supply-demand relationship in Morocco is influenced through climate change and socioeconomic, industrial and in particular tourism development as well as the water consumption of hotels. The objective of the study has been met and the main research question answered.

In order to answer the research questions, a mixed-method approach consisting of desk research, literature review and field research including informal interviews and questionnaires has been taken on. The desk research gave valuable insight into the projections of future climate change until the end of the century under different scenarios. One of the most important general findings is the detection of the critical water situation of Morocco and that this area is one of the most vulnerable regions in the world, where climate change will exhibit the most extreme impacts. While temperature will increase by 2-3°C on average in Morocco (up to 5°C in summer months), precipitation will decrease by 20-60%, which will affect water supply and water demand. These warmer and drier conditions will lead to enhanced evaporation and the depletion of aquifers and groundwater reservoirs. Water supply is expected to decrease by 1.4x to 1.7x from the baseline in 1950-2010 to 2040 under the *business as usual* model, mostly due to changes in climate. Water demand will increase by 1.2x to 1.7x in comparison to the baseline because of socioeconomic development such as population growth and tourism development. In Morocco, the diminishing water supply is more significant than the increasing water demand and as a result, water stress will increase. Even though tourism in Morocco does not yet have a great share of the national's water use in general, the growing tourism sector must be seen as an additional water consumer. As tourism develops and numbers rise, the water demand will increase as well. To counteract the extreme changes, the reduction target for the overall water demand has been set to 40% for the end of the century, of which the hotel industry as a growing industry should be responsible for 10%.

Within 2.5 weeks of field research in different places in Morocco, water consumption data from eleven hotels have been collected. The hotels from all around Morocco use 310 litres of water on average per guest night. The water is mainly provided by a public service/municipality or comes from a well. Severe differences of the quantity of consumed water exist. In general, bigger and more luxury hotels use more water than small-scale accommodations. Having a pool and a garden that needs to get irrigated increases the water demand of the hotel as well. Based on the results, three accommodation categories have been developed and their water consumption analysed and compared. The proposed

adaptation strategies for hotels range from direct water reduction measurements like reducing shower time and flow to rainwater harvesting, water reuse and the commitment to higher level environmental standards and strengthened collaboration between hotels and increased public-private partnerships. If hotels take on the recommendations and implement water reduction measurements, the goal set in SRQ2 can be reached. Hotels have many options to adapt to future water scarcity. In an era of climate change it is important to use and manage water sustainably, thus more water needs to be derived from renewable sources. Desalination as a viable option of freshwater supply is being proposed to the hotels. Since the water balance is getting lower, no matter the climate change scenario, increased focus should be laid upon boosting water supply. It is impossible to reduce water demand by 100% as water is life and freshwater essential in all practices.

This study has shown that the impact of climate change on the water supply-demand relationship is extreme in Morocco and that the hotel industry needs to take action to cope with the projected changes in order to be economically successful in the future. The government is investing in tourism to be the engine of the economy and a strong increase in tourist arrivals is expected in the next years. This will impact the water demand even more and competition for water resources between domestic use, agriculture, industry and tourism will increase. Despite the government's vision to become one of the 20 leading global destinations and to be a sustainable leader in the Mediterranean, political will and financial means are lacking to implement environmental standards and rules on the hotel industry. It is therefore the role of scientists to address this dilemma and set the challenge against water scarcity on the agenda to allow tourism to develop while water is being used sustainably.

10. SUGGESTIONS FOR FURTHER RESEARCH

Further research could include food as the main source of indirect water consumption in a hotel. As already stated, the production, transport and preparation of food incorporates a lot of water, which has not been considered in this study. Furthermore, it is central to include the Water Foodprint in the assessment of the overall WF in a hotel. However, since no method exists yet on how to calculate the WF for a hotel as an entity, this has to be developed first. The WF can also be calculated for one specific tourism product, for instance desert tourism into the Sahara. Moreover, different geographic locations should be considered next time. Since water consumption differs per area, focus could be on either a tourism hotpot like Marrakech, or a coastal destination namely Agadir, Essaouira or Tanger in the northwest of Morocco. Also, a research gap is the missing locus of luxury hotels only as these are the ones who are consuming most of the water and therefore have a higher responsibility towards sustainable water management. These group of hotels were unable to access in this study. Another study could focus on testing the proposed adaptation strategies if they get implemented by hotels and if the reduction target has been met. Related to this, research could focus on the impact of further tourism development on the water availability for the local population and a potential water crisis at the end of the century, when climate change impacts will even more striking.

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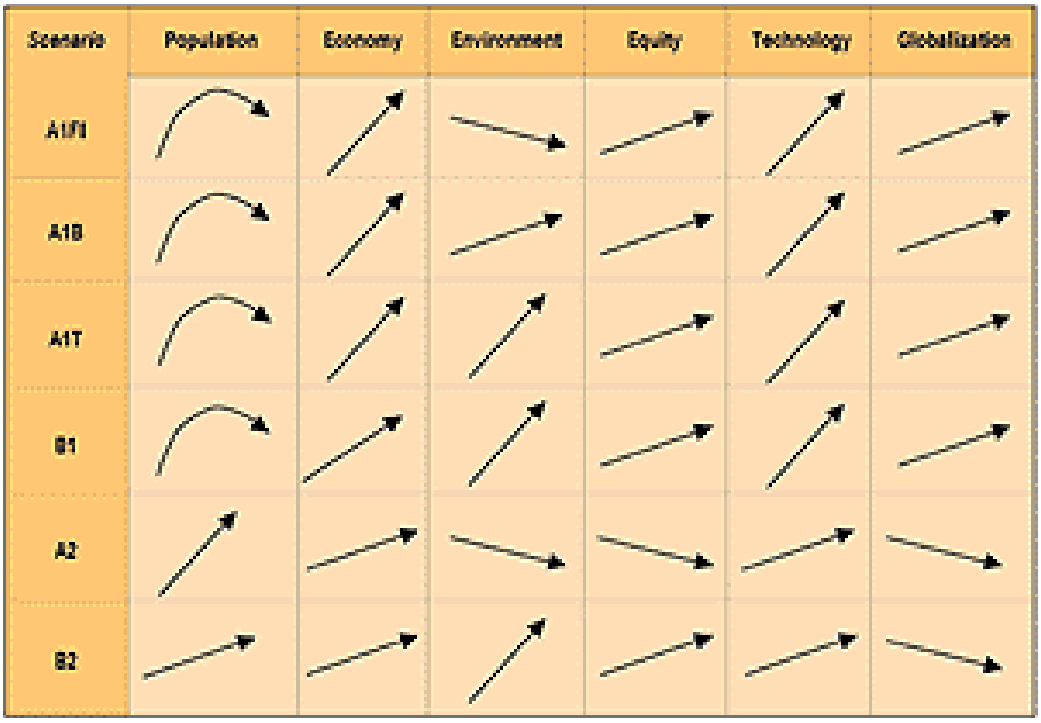
12. APPENDIX

Appendix A: Characteristics of SRES scenarios.

Qualitative directions for different indicators.



Source: Metz, 2001

Appendix B: Environmental Footprint Study in AccorHotels

Source: AccorHotels, 2014

Appendix C: Water Footprint Assessment Questionnaire

Water Footprint Assessment

My name is Wiebke Homes and I am a Tourism student at Wageningen University in the Netherlands. Currently, I am writing my Bachelor Thesis on the adaptation to climate change induced changes in the water supply and demand in the tourism industry in Morocco. Therefore, I am assessing the Water Footprint of hotels in Morocco by calculating the amount of water consumed in hotels. You will benefit through participating in this survey by receiving options on how to better adapt to changes in the water supply in an era of climate change and water scarcity. The responses will be held strictly confidential and only serve the purpose of this study. They will not be handed to third parties. The survey is voluntary, in English and will take about 10-15 minutes. This thesis is supervised by Dr. Bas Amelung (bas.amelung@wur.nl). If you have any questions, feel free to contact me through email (wiebke.homes@wur.nl). Thank you very much in advance!

Hotel name

How many starts does your hotel have?

- ❍ 1
- ❍ 2
- ❍ 3
- ❍ 4
- ❍ 5

How many rooms does the hotel have?

On average, how many guest nights do you record per year in your hotel?

General hotel information

Swimming Pool

Does your hotel have a swimming pool?

- ❍ Yes
- ❍ No

If yes, how big is the swimming pool?

Garden

Does your hotel have a garden or other outside areas that get irrigated?

- ❍ Yes
- ❍ No

If yes, what is the total area of outside space irrigated?

How many weeks does the outside space gets irrigated during a year?

Laundry

How many tons of laundry do you have per year?

Do you outsource your laundry?

- ❍ Yes
- ❍ No

Water use in your hotel (Part 1)
Total amount of water used per type. If you do not know the exact amount of water used, then state an estimation. If your hotel does not have a pool or other amenities, please state 'not applicable'.

How much water is used within one year for the following types?

Guest rooms (includes shower, toilet, sink)

Swimming Pool

Irrigation

Kitchen

Laundry

Other

What is the total amount of water used in your hotel in one year?

Water use in your hotel (Part 2)
Water source

Where does your water come from?

- ❍ Public network / Municipality
- ❍ Tank
- ❍ Well
- ❍ Desalinated water
- ❍ Other

What percentage of water comes from a ...
Please estimate the percentage of each source. It should add up to 100%. If water does not come from the stated source, then please state 0.

...public network / Municipality? (metered and unmetered)

...tank?

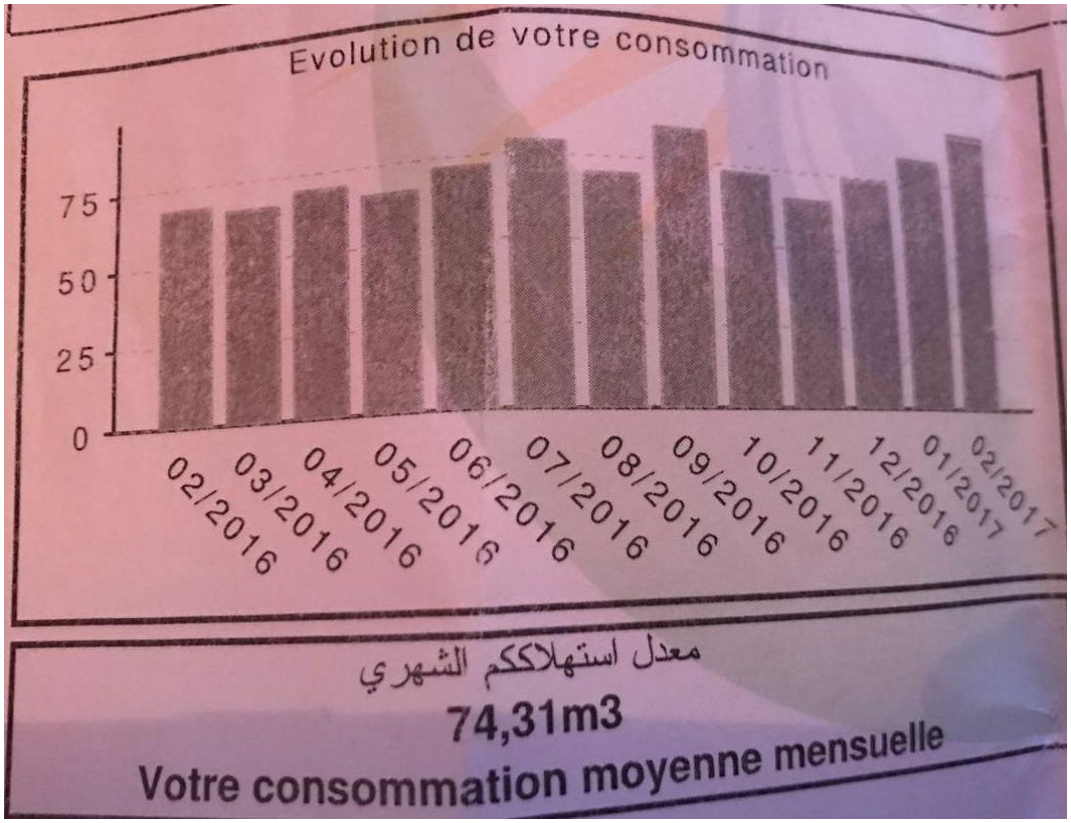
...well?

...desalinated water?

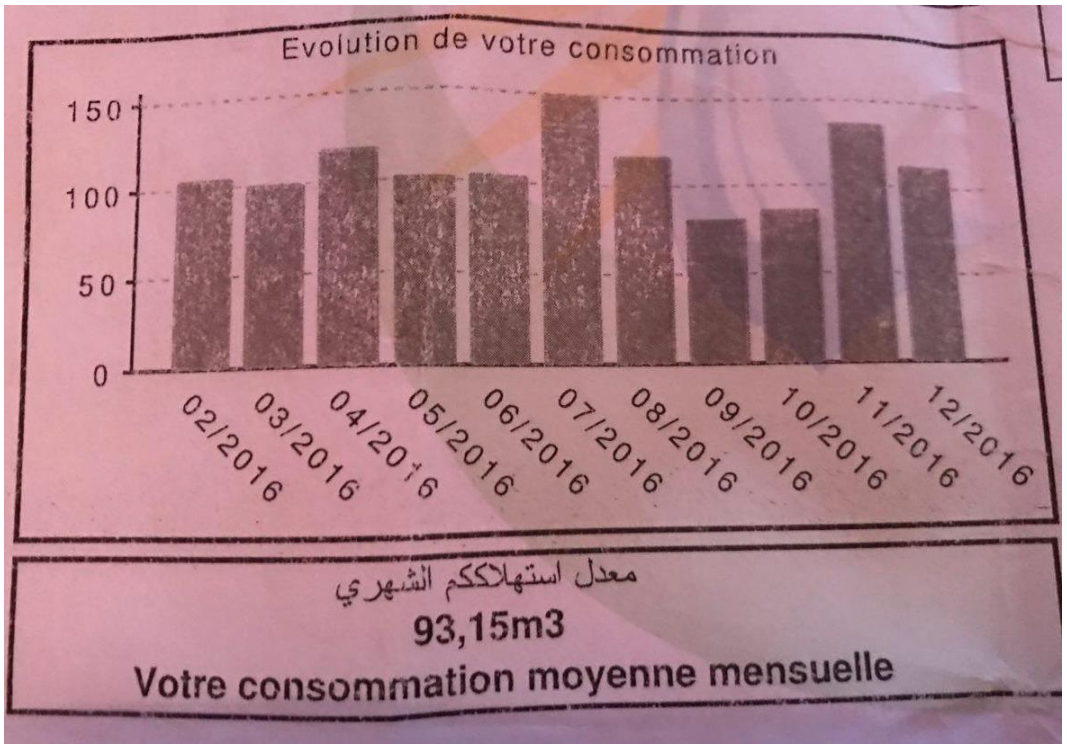
...other sources? Please specify the source.

Thank you for participating!
If you would like to receive options on how to better adapt to changes in the water supply in an era of climate change and water scarcity when the study is done, please leave your email address here:

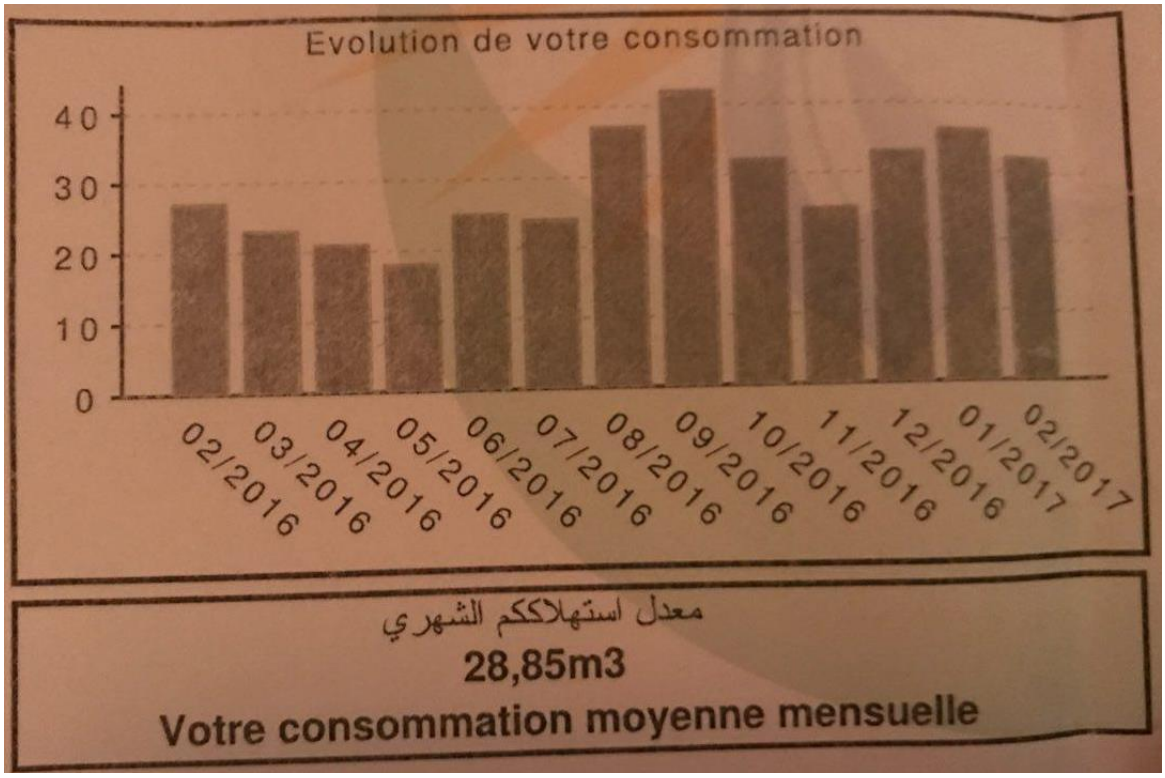
Appendix D: Water consumption in m³ per month for Riad Atlas



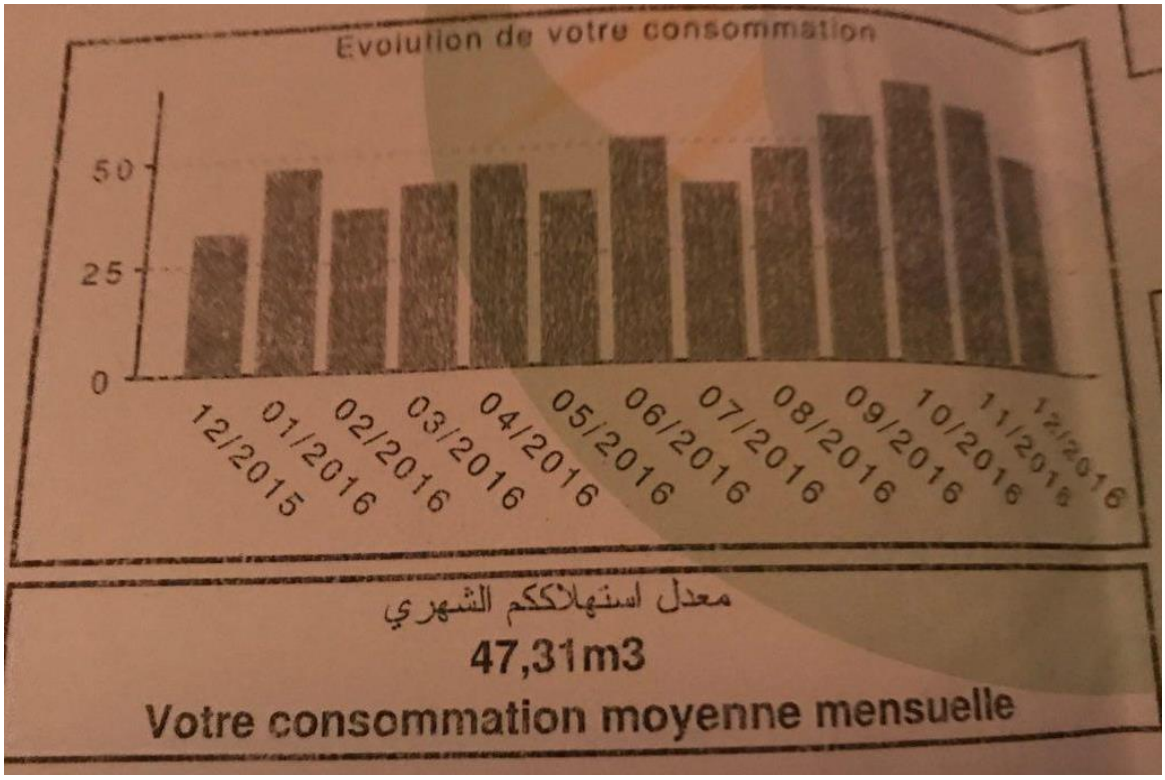
Appendix E: Water consumption in m³ per month for Riad La Caleche



Appendix F: Water consumption in m³ per month for Dream Kasbah



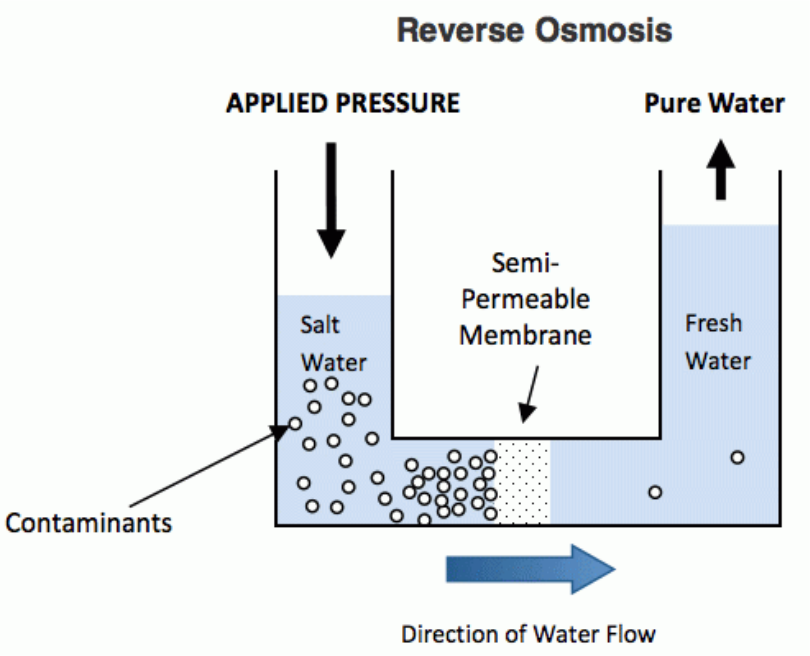
Appendix G: Water consumption in m³ per month for Kaktus Hostel



Appendix H: Water saving sign

Example of sign used in bathroom to increase the guest's awareness of how much water is used for a shower. This sign was found in the Atlantic Hostel in Essaouira, Morocco.

Appendix I: Desalination process



Source: Burger, 2014.