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Can we cut the water footprint of Finland by changing diet?

Master's thesis submitted for inspection for the degree of Master of Science in Technology.

Espoo, September 7th, 2015

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Abstract of master's thesis

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Abstract

Previous studies have shown that a diet change and waste reduction have shown possibilities in reducing water consumption. By using the available resources sustainably it can result in reduced water scarcity and deliver improved food security. In this study I aim to assess how a diet change would impact on Finnish water use for food production.

First the water consumption of the current Finnish diet is calculated. Then the diet was adjusted to correspond with the dietary recommendation. Thereafter, the amount of animal products is gradually reduced in three steps, 50%, 25% and 0%. In addition to this, the water footprint of two specific diets, Pale and Mediterranean is calculated.

The blue water footprint increased by 3 – 23% for the animal protein scenarios compared to the recommended diet while the green water decreased by 4 – 22%. The water footprint of Paleo diet increased by a remarkable 67% and 56% for the blue and green water footprint respectively. The Mediterranean diet resulted in a high blue water footprint (58% increase) while the green water footprint is similar to that of the current diet.

The results of this study shows that changes in diets can have a clear impact on the water consumption of producing food. Studying the water consumption on a country level with local recommendations gives a deeper insight into how the diets affect the water footprints. Finland is a country with high consumption of animal products and a high daily energy intake, reducing the energy intake and amount of animal products can decrease the water footprint of a diet in Finland.

Keywords water footprint, diet change, water use, sustainable consumption, green water, blue water

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Sammandrag av diplomarbetet

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Sammandrag

Tidigare studier har påvisat att en diet förändring och avfallsminskning har varit tecken på möjligheter till att sänka vattenförbrukningen. Genom att använda tillgängliga resurser på ett hållbart sätt kan det vara möjligt att vattenbristen minskar och mat säkerheten förbättras. Målet med den här studien är att försöka utreda hur en diet förändring påverkar vattenförbrukningen inom livsmedelsproduktionen i Finland.

Till en början räknade vi ut vattenfotavtrycket för den aktuella dieten i Finland. Sedan justerades dieten till att följa näringsrekommendationerna. Därefter minskades mängden animaliska produkter gradvis i tre steg, 50 %, 25 % och 0 %. Utöver dessa räknades vattenfotavtrycken för två specifika dieter, Paleo- och Medelhavsdieten.

Det blåa vattenfotavtrycket ökade med 3 – 23 % då animaliska produkter minskade jämfört med den rekommenderade dieten medan det gröna vattenfotavtrycket minskade med 4 – 22 %. Vattenfotavtrycket för Paleo dieten ökade med hela 67 % och 56 % för det blåa och gröna vattenfotavtrycket. Medelhavsdieten hade ett högt blått vattenfotavtryck (58 % ökning) medan det gröna vattenfotavtrycket liknade det av den aktuella dieten.

Denna studie visar att en diet förändring kan ha en klar påverkan på vattenförbrukningen för livsmedelproduktionen. Genom att studera vattenanvändningen på landnivå och med lokala rekommendationer ger det en djupare uppfattning av hur en diet påverkar vattenförbrukningen. I Finland konsumeras mycket animaliska produkter och det dagliga energi intaget är relativt högt. Genom att minska på energi intaget och mängden animaliska produkter kan vi minska på vattenfotavtrycket i Finland.

Nyckelord vattenfotavtryck, diet, vattenanvändning, hållbar konsumtion, grönvatten, blåvatten

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Annica Ahlström

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1 Introduction

The rapidly growing population will increase the demand for food and water in the future. Many areas around the world are already suffering from water scarcity (Kummu et al., 2014; Wada et al., 2011) and inadequate nutrition (Porkka et al., 2013). Moreover, agriculture uses almost 40% of Earth's land surface and as much as 90% of all fresh water consumption (FAO, 2015). Finland has water and land resources are sufficient for food production, yet through import of food and other agricultural products it is also consuming resources from other countries, where shortage of both water and land may occur (Sandström et al., 2014; WWF, 2012).

Finland consumes 7 326 billion liters of water yearly, which include the blue (6%), green (75%) and grey (20%) water. Blue water is surface and groundwater, green water is water stored in the soil, and grey water is used to assimilate pollutants (Hoekstra and Mekonnen, 2012). From the 7 326 billion liters of water agriculture amounts for 82%. Only half of the water consumed in Finland (53%) is domestic, and the rest is water used to produce imported products consumed in Finland (WWF, 2012). Most of this water is so called virtual water, the water used to produce a product; it contains all the water used throughout the supply chain. This number is usually much higher than the actual water content of a product (Hoekstra and Mekonnen, 2012). About 500 000 ha of land area is used for agriculture and food production in Finland (about 8% of land area (FAO, 2015) and apart from that 700 000 ha of agricultural land area is used outside the country boundaries to produce imported products consumed in Finland (Sandström et al., 2014).

Research has been conducted on the relationship between water consumption of food production and diets, on both global scale and country level (see e.g. Jalava et al., 2014; Vanham et al., 2013a, 2013b). Producing different food products require different volumes of water and these numbers also vary a lot from country to country. For example, the water footprint of beef (i.e. the volume of water consumed during production) in Finland is about 3300 l/kg. The same number for beef produced in Brazil and Hungary is 8200 l/kg and 25000 l/kg respectively (Mekonnen and Hoekstra, 2011, 2010; Siebert and Döll, 2010). In addition, people's daily diets can be very different from one country to another, and therefore needs to be studied locally.

Globally the diet is becoming more animal concentrated and the consumption is increasing (Porkka et al., 2013). In Finland, for example, meat and dairy products are a big part of the diet, and they account for about 40% of the daily energy intake (FAO, 2015). This is much higher than in other countries. It is known that animal products tend to have a higher water footprint than crop products (Baroni et al., 2006; Hoekstra and Chapagain, 2006; Vanham et al., 2013a). Therefore, with rising consumption of animal products the water footprints of our diets are also increasing.

This study aims to assess how a diet change would affect the water resources used to produce food. The main focus is on Finland's water footprint. To get a better understanding of the influence of different diets on water consumption in a country with high consumption of animal products, as Finland, we compare three scenarios where the amount of animal protein is reduced gradually. In addition to this, we calculate the water footprints of two specific diets, the Paleo diet and the Mediterranean diet. Both diets have increased in attractiveness due to their claimed health benefits (Alessandro and De Pergola, 2014; Estruch et al., 2013; Lindeberg et al., 2003; Trichopoulou et al., 2003).

2 Materials and methods

The first step of this study was to calculate the water footprint of Finland's current food intake (Original Diet, OD). The original diet was then adjusted to follow the dietary guidelines for a recommended diet by the National Nutrition Council of Finland (VRN, 2014) and the average dietary energy requirements (ADER) of developed countries, reported by the FAO (FAO, 2015) (Recommended diet, RD). Thereafter, the animal protein was gradually reduced in three different phases, A50, A25 and A0. For the Paleo and Mediterranean diets I used the nutrition compositions reported in Jönsson et al. (2010), which were independent from the OD or RD. After that, the diets were scaled so that the calorie intake would correspond to the ADER. Finally, the water footprints were calculated for all the diet scenarios. Table 1 describes the different diet scenarios. Figure 1 presents the workflow for calculating the water footprint of the animal protein scenarios and for the Paleo and Mediterranean diet scenarios. For the water footprints, the blue water (surface and groundwater) and the green water (stored in the root zone area) were taken into account. The grey water (assimilation of pollutants) was not included in this analysis (Hoekstra et al., 2011). The methods will be described in more detail in the following sub-sections.

Table 1 *Diet scenarios.*

Diet Scenario	Definition	How computed
Original Diet (OD)	Current Finnish diet	Food supply data from FAO's Food balance sheets
Recommended Diet (RD)	Diet following the dietary guidelines of NNC[1] and energy intake conform to ADER[2]	OD adjusted to follow the dietary guidelines
A50	Animal products only 50%	Reducing animal products from the RD
A25	Animal products only 25%	Reducing animal products from the RD
A0	Animal products only 0%	Reducing animal products from the RD
Paleo Diet	Sample diet with values from (Jönsson et al., 2010)	Scale to correspond to ADER
Mediterranean Diet	Sample diet with values from (Jönsson et al., 2010)	Scale to correspond to ADER

[1] NNC – The National Nutrition Council of Finland (VRN, 2014)
[2] Average dietary energy requirements by FAO (FAO, 2015)

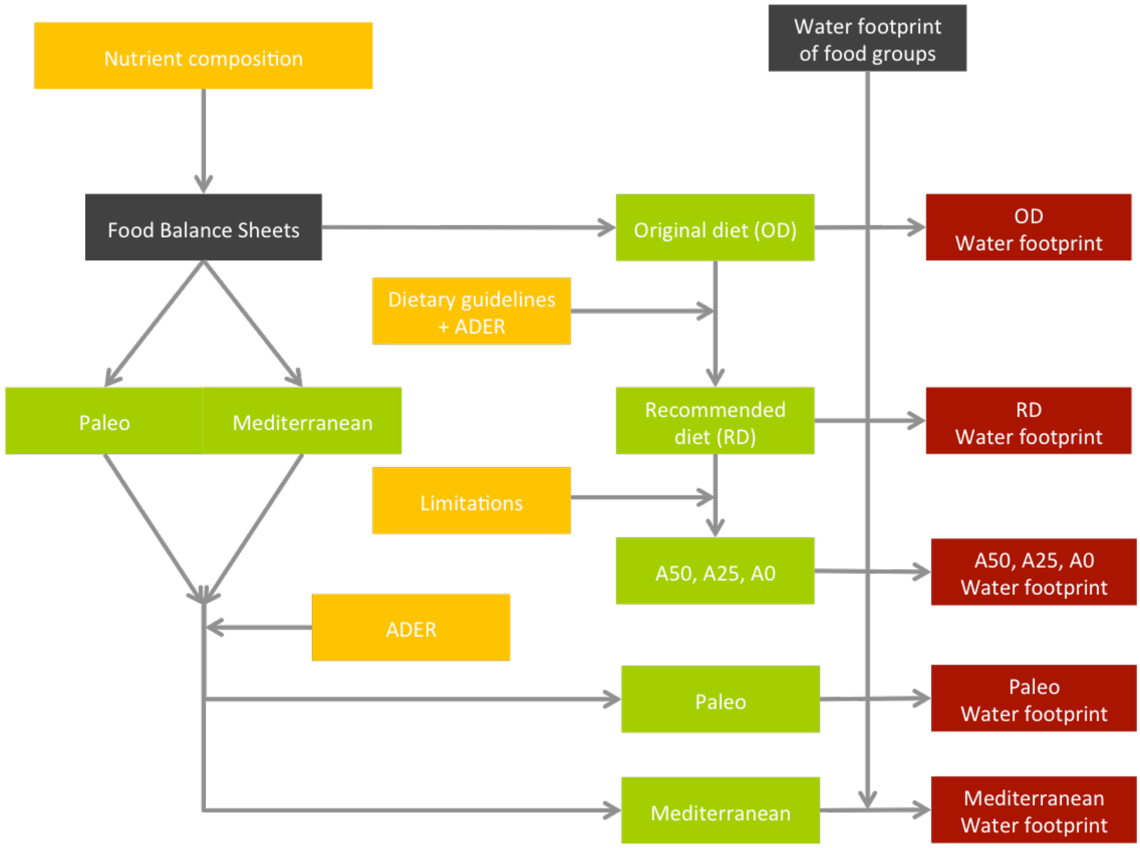

Figure 1 *Method for calculating the water footprints of the diet scenarios. Dietary guidelines based on VRN (2014), ADER refers to average dietary energy requirements for developed countries reported by the FAO (2015) and nutrient composition based on Jönsson et al. (2010).*

2.1 Food supply data

For the original diet (OD), this study utilized food supply information from the FAO (United Nations Food and Agriculture Organization) Food Balance Sheets (FAO, 2015). To reduce the effect of year-to-year variation three-year average values were used. The food supply numbers include the domestic production and net imports of different food products and product groups, adjusted for changes in stocks.

The food products were divided into 13 groups for each diet scenario. The vegetal-based food groups were cereals, fruits and vegetables, oils, oilseeds, and roots. The animal-based food groups were eggs, meat and milk. Additional food groups were fish, beverages, spices, stimulants, and sugar; they were included in the water footprint calculations but not adjusted in the diet scenarios. The consumption of fish was limited to its current levels, as many of the world's wild fisheries are already suffering from over-exploitation. While aquaculture might provide options to increase fish consumption, the related environmental impacts, such as water consumption of feed, are not well known. For health reasons beverages and sugar were kept the same as in the OD, as it is not recommended to increase the consumption of either product. The consumption of spices and stimulants has little effect on the diet and its water consumption, and they are used mostly for taste and cultural reasons.

2.2 Animal protein diet scenarios

For the recommended diet (RD), the average food intake was adjusted to correspond to the average dietary energy requirement ADER (FAO, 2015), which is 2508 kcal/day for developed countries. It was further adjusted to follow the macronutrient recommendations by the National Nutrition Council of Finland as described in Table 2 (VRN, 2014).

Table 2 *Nutrient recommendations and animal protein limitations for optimization.*

Scenario	RD	A50	A25	A0
Energy intake [kcal/cap/day]	2508	2508	2508	2508
Protein [% of energy]	10–20%	10–20%	10–20%	10–20%
Fat [% of energy]	25–40%	25–40%	25–40%	25–40%
Fruits & vegeta-bles	≥ 500 g/cap/day	≥ 500 g/cap/day	≥ 500 g/cap/day	≥ 500 g/cap/day
Animal products- eggs- meat- milk	min change	≤ 50% of protein	≤ 25% of protein	0%
of which meat	min change	≤ 16.7% of protein	≤ 8.3% of protein	0%
Sugar [% of energy]	≤ 10%	≤ 10%	≤ 10%	≤ 10%

Starting from the RD, within the A50-A0 scenarios, the animal protein was reduced gradually in a way that the previous restrictions, dietary guidelines and other limitations, were still valid. In these three scenarios, animal products were limited to 50%, 25% and 0% of which meat products could only comprise one third (Table 2). In these scenarios, animal protein was replaced with plant-based protein sources, in this case oilseeds and roots were preferred, this to maintain a diet that follows the dietary guidelines and to preserve a good amino acid composition. The adjustments were done using quadratic programming. The purpose was to find a diet that meets the dietary requirements and limitations but differs as little as possible from the RD. This was done to maintain a culturally accepted diet. A detailed description of the diet adjustment methods can be found in Jalava et al. (2014).

2.3 Paleo and Mediterranean diet scenarios

The Paleo and Mediterranean diets' nutrition composition differs significantly from a typical Finnish diet (Table 3). Thus, calculating the water footprint of these diets gives a more clear understanding of how different food groups could affect the water footprint.

The Paleo diet, or "the caveman diet", aims to mimic the diet of the Paleolithic era. The diet avoids processed food like cereals, dairy products, alcohol, and refined sugar. The main sources of energy in the Paleo diet are fruits and vegetables, meat, fish, nuts and seeds (Cordain, 2010; Eaton, 2006; Whalen et al., 2014).

The Mediterranean diet originates from the area around the Mediterranean Sea. The diets consist of a great amount of vegetables, fruits, and lean meat. Olive oil is important, and it is the main source of fat. The Mediterranean diet favors a low consumption of red meat and dairy products, preferably only cheese and yoghurt (Alessandro and De Pergola, 2014; Trichopoulou et al., 2003; Whalen et al., 2014).

Table 3 *Nutrient recommendations of the Paleo and the Mediterranean diets (E%).*

	Paleo	**Mediterranean**
Energy intake [kcal/cap/day]	2508	2508
Fat [% of energy]	21 – 35%	22 – 34%
Carbohydrates [% of energy]	28 – 39%	40 – 54%
Protein [% of energy]	21 – 33%	17 – 23%

For the Paleo and Mediterranean diet scenarios I used the diet composition described in Jönsson et al. (2010), including both macronutrients (Table 3) and dietary variables. The values were then scaled so that the calorie intake would conform to the ADER of developed countries. Stimulants and spices were kept at the same levels as in the original diet (OD).

2.4 Water use of diet scenarios

For each diet scenario the consumptive water use was estimated. To start with, for individual food products, water footprint data by Mekonnen and Hoekstra (2011, 2010) were used. The water footprint data were then further completed with numbers from Siebert and Döll (2010) for pasture and grass. The Paleo and Mediterranean diets were additionally completed with information from Mekonnen and Hoekstra (2011) for juices, jams, and bakery, and from Ridoutt and Pfister (2010) for sauces.

With domestic production, the water footprints data used were specific for Finland. In the few cases where data for Finland were not available, global average values were used. For the imported products a weighted global average value of exported foodstuff in question was used. It was calculated by summing all the exported water use and then assigned to particular countries depending on their imports.

The water footprints of the diets (l/cap/day) were calculated by multiplying the food supply (g/cap/day) with water footprints (l/g) of crops and animal products (l/cap/day = g/cap/day x l/g). A more detailed description on how the water footprints were calculated can be found in Jalava et al. (2014).

3 Results

3.1 Original diet and recommended diet

A Finnish diet today comprised of mostly cereals and a lot of dairy and meat products. In Finland 61% of the energy intake came from vegetable products and 39% from animal products. The three biggest food groups were cereals, meat and dairy products and they accounted for almost 60% (Figure 3 and 4) of the total energy intake of 2836 kcal/cap/day of the OD (ADER for developed countries is 2508 kcal/cap/day). The water footprint for Finland's food consumption in the OD was 248 l/cap/day for blue water and 2850 l/cap/day for green water (Table 4 and Figure 2).

In the recommended diet the energy intake decreased by 12% compared to the original diet. This naturally also led to a reduction in the water footprint, by approximately 7% overall (see Table 4 and Figure 2). The water footprint of meat and milk products decreased along with the water footprint of cereals and oils in the RD. The only group whose intake increased in the RD compared to the OD was fruit and vegetables, rising by a remarkable 25% (Figures 3 and 4). Some small changes occurred in other groups, however they did not affect the water footprint in any substantial way.

Table 4 *Water footprint for different scenarios. All water footprints are compared to recommended diet (RD)*

	Blue water (l/cap/day)	**Green water** (l/cap/day)	**TOTAL** (l/cap/day)
Original diet (OD)	248 (+8%)	2850 (+8%)	3098 (+8%)
Recommended diet (RD)	230 (0%)	2631 (0%)	2862 (0%)
A50	238 (+3%)	2516 (-4%)	2754 (-4%)
A25	268 (+17%)	2213 (-16%)	2481 (-13%)
A0	282 (+23%)	2064 (-22%)	2347 (-18%)
Paleo	383 (+66%)	4103 (+56%)	4487 (+57%)
Mediterranean	364 (+58)	3048 (+16%)	3412 (+19%)

3.2 Animal protein scenarios

When animal protein was gradually reduced in the following scenarios, we found that green water footprint decreased significantly but, surprisingly, the blue water footprint of the diet increased somewhat. In the A50 scenario, the blue water footprint increased by 3% and the green water footprint decreased by 4% compared to the RD (Table 4 and

Figure 2). The water footprint of meat products almost halved resulting in a decrease of the green water footprint. The animal products were replaced with oilseeds, roots and cereals, resulting in an increase in their water footprints: the water footprint of oilseeds nearly doubled and the water footprint for roots increased by as much as 60% (Figure 3 and 4).

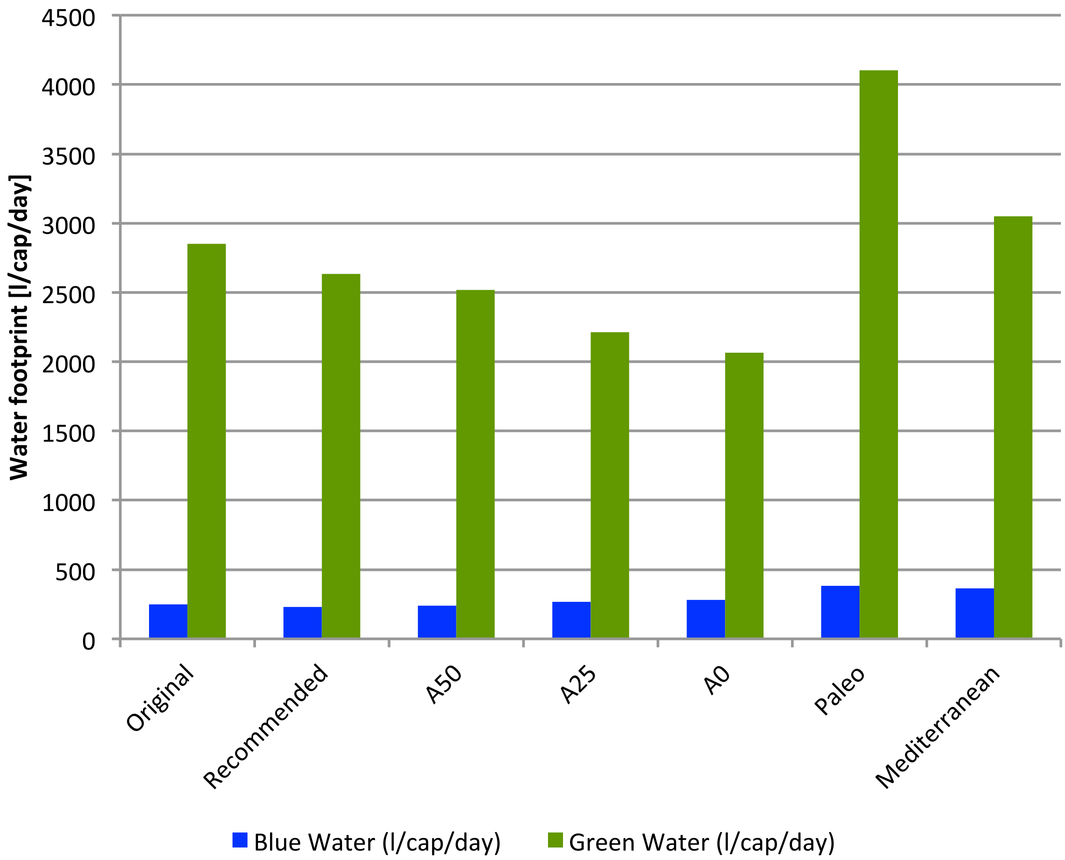

Figure 2 *The blue and the green water footprint for different diets.*

In the A25 scenario the blue water footprint increased and the green water footprint decreased, with 17% and 16%, respectively compared to the RD (Figure 2). There was further reduction of meat and milk products, resulting in a remarkable 80% decrease of the water footprint of meat and 60% for milk. Oilseeds, roots, cereals, oils, fruits and vegetables replaced the animal products. The water footprint of oilseeds almost tripled and for roots it increased by 122% compared to the RD. The water footprint of cereals also increased by over 50% (Figure 3 and 4).

In the A0 scenario, all the animal products were replaced by plant-based products. The total water footprint decreased with 18% compared to the RD. Here cereals, oilseeds, oils and roots replaced milk and meat products. The total water footprint increased by 70% for cereals, by 94% for oils, by 155% for roots and by 330% for oilseeds respectively (Figure 3 and 4). This resulted in a significant 23% increase of the blue water footprint but sill a 22% reduction of the green water footprint (Table 4).

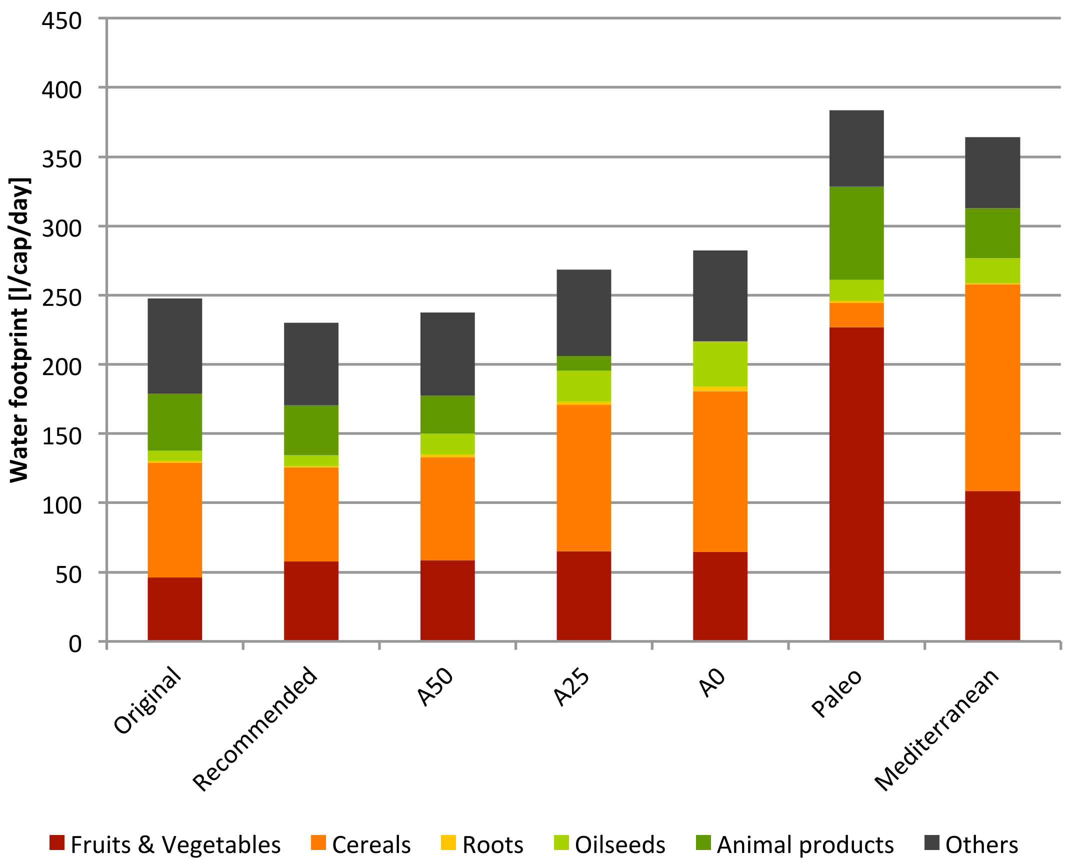

Figure 3 *Distribution of the blue water footprint.*

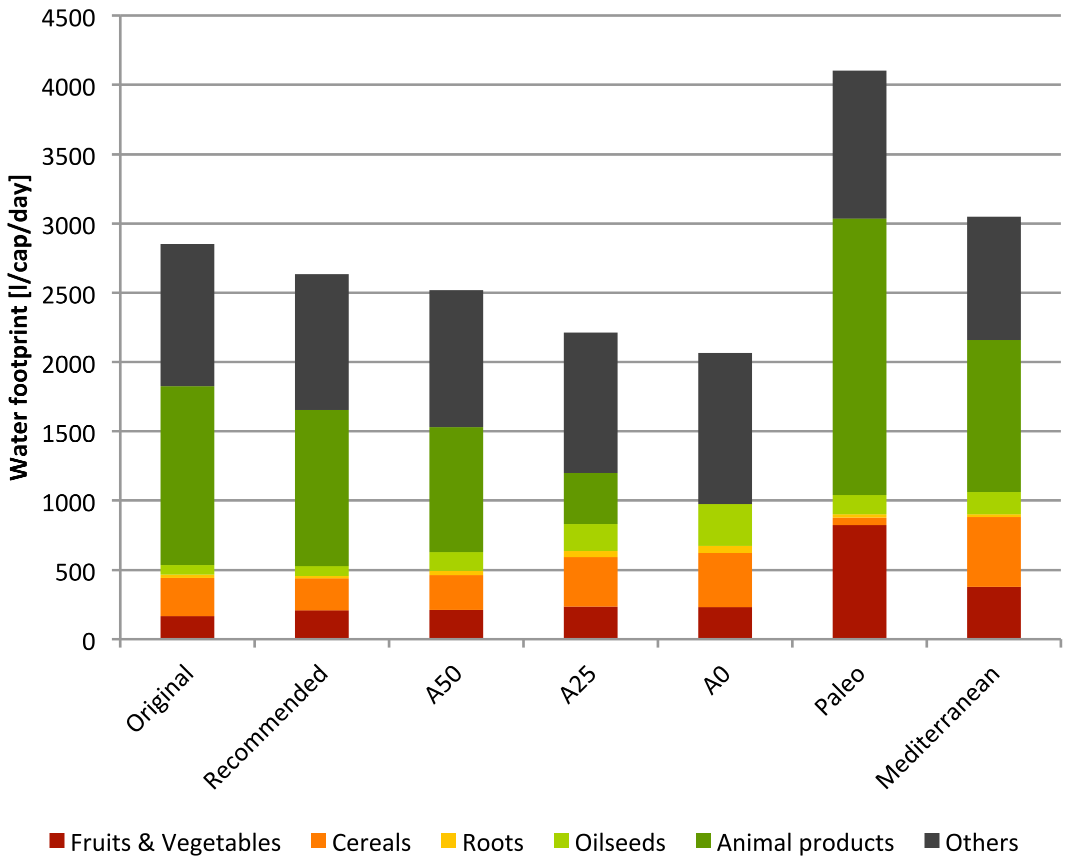

Figure 4 *Distribution of the green water footprint.*

3.3 Paleo and Mediterranean diet scenarios

The Paleo diet scenario had a relatively high water footprint, compared to all the other diets, even the OD that had a much higher energy intake (Table 4). The blue water footprint of the Paleo diet increased by a remarkable 67% compared to the RD. The green water footprint also increased nearly 56% (see Figure 2). The Paleo diet was high in meat products, oilseeds, fruit and vegetables but there were hardly any milk products and very little cereals compared to the RD. The biggest food groups were meat, oilseeds, fruits and vegetables, and they accounted for approximately 70% of the total water footprint (Figure 3 and 4). The Paleo diet consisted of plenty of meat products, fruit and vegetables, which gave the diet a high blue and green water footprint compared to the RD.

In the Mediterranean diet scenario, the blue water footprint was also higher than the OD's blue water footprint, even though OD had a much higher energy intake, yet the green water footprint was quit similar to the OD. The blue water footprint increased by

58% compared to the RD and the green water footprint by 16% (see Table 4 and Figure 3). The water footprint of cereals and oilseeds were twice as high and for fruits and vegetables almost 90% higher compared to the RD. The water footprint of meat products was only 36% higher and that of milk products decreased by nearly 50% compared to the RD (Figure 3 and 4). The Mediterranean diet contained a lot of cereals, oilseeds, fruits and vegetables, which also led to a high blue water footprint but the green water footprint only increased a fraction compared to the blue one.

4 Discussion

The results of this study shows that changes in diets have a clear impact on the water consumption of growing food. In Finland, replacing animal protein with plant-based protein decreases the green water footprint but increases the blue water footprint due to higher irrigation demand of vegetal products. Furthermore the Paleo and Mediterranean trend diets consume much more water than all the other diet scenarios because of their high meat, fruit and vegetable intake. Replacing animal products in the Finnish diet can reduce the total water footprint by 4 – 18%.

4.1 Comparing the use of water

This study gives a clearer understanding of how the water consumption in Finland is affected by a diet change when using local recommendations. Previously, research has been done on water consumption on global and regional scales but at country level (Jalava et al., 2014; Vanham et al., 2013a). The Finnish diet's blue water footprint (248 l /cap/day) is a bit lower than the world's average of 390 l/cap/day, however the green water footprint (2850 l /cap/day) is slightly higher than the world's average of 2350 l/cap/day (Jalava et al., 2014). The OD of Finland has a higher water footprint than the one calculated by Vanham et al. (2013a) for the current diet of northern countries in the EU. The RD has an almost similar water footprint to that of a healthy diet in Vanham et al. (2013a). While the Mediterranean diet's water footprint for Finland, according to this study, is much lower than that for the southern part of EU following a Mediterranean diet (Vanham et al., 2013a). This can be explained by higher water footprints of food production in the south due to climatological conditions. The results obtained here differs somewhat from that of Jalava et al. (2014) and Vanham et al. (2013a).

In Finland the blue water footprint of the diets increases when reducing animal products and replacing them by plant-based products. The Finnish diet has a quite high content of meat and dairy products, so to maintain the same nutritional composition, they need to be replaced by a lot of plant-based products, as in this case oilseeds, cereals, fruits and vegetables. The plant-based products have often a higher blue water footprint than animal products but a significant lower green water footprint in Finland. Plant-based products require more irrigation than animal products resulting in higher blue water footprints. So naturally, when reducing animal protein the green water footprint of the diet decreased and the blue water footprint increased. In addition to differences in water footprints of food groups, replacing animal products with plant-based products and maintaining the same nutritional values requires higher quantities of food due to the lower protein content in plant-based products. These two factors explain the great increase in water footprints of plant-based products, particularly in terms of blue water. However, animal products have so much higher green water footprints compared to the plant-based products that the total water footprint of diets nevertheless decreased in all the animal protein scenarios. These also require more irrigation water than animal products leading to higher blue water footprints. Both Jalava et al. (2014) and Vanham et al. (2013a) came to the same result in their studies, the blue water footprint increases when switching from animal-based products to plant-based products in Finland.

In previous studies WHO's dietary recommendations have been used while in this study I used the National Nutrition Council of Finland's values (see Table 5). This automatically results in different values. By using the National Nutrition Council's recommendations to adjust the Finnish diet, I found that the water footprints were higher compared to the results obtained by using WHO recommendations (see Jalava et al. 2014).

Table 5 *Dietary recommendations by The National Nutrition Council of Finland (VRN, 2014) and WHO (WHO, 2003).*

Dietary factor	The National Nutrition Council	WHO*
Total protein	10 – 20%	10 – 15%
Total fat	25 – 40%	15 – 30%
Total carbohydrates	45 – 60%	55 – 75%
Free sugars	< 10%	< 10%
Fruits and vegetables	min 500 g/day	min 400 g/day

* values are% of energy intake

I found that there is great potential to decrease the water footprints of Finland due to the high content of animal products in the OD compared to the A0 where no animal products are allowed. This can be compared to, for example many Asian countries, which are already consuming a diet high in vegetal constituents and thus further reducing the amount of animal products there would have only small water saving potential (Jalava et al., 2014). In this study, removing the amount of stimulants would also lower the total water consumption with around 20% in all the diet scenarios due to the high water footprint of coffee and tea.

4.2 The effects of diet change

A typical diet today is characterized by high energy intake with more added sugar and fats, and less fruits and vegetables (WHO, 2003). The nutritional values in the food products are not as high as they used to be because of the intensified production and industrialization (Eaton, 2006).This poses a problem in today's society where the challenge is to maintain a sustainable diet with good nutritional values while still having a low water footprint.

Research has been done on Paleo and Mediterranean diets' health benefits. Studies have found that both diets have lead to recovery of chronic diseases (Cordain, 2010; Estruch et al., 2013; Frassetto et al., 2009; Serra-Majem et al., 2006). My findings indicate, however, that the potential health benefits come at the cost of higher water footprints; at least in Finland.

There has also been a lot of discussion in the news that changing to meat and dairy free diets helps us save resources and eradicate hunger (Carus, 2010). People are getting more concerned and interested in the sustainable use of our planet's resources. Previously, diet change and water scarcity have mainly been a topic for scientists and researchers, but with the increased interest towards a sustainable living, this is something that concerns everyone.

Reducing the amount of food losses and waste can also save resources, such as water and crop area. In terms of calories, one-quarter (Kummu et al., 2012) and respectively in terms of kilograms one-third (Gustavsson et al., 2011) of the food produced goes to waste or is lost. Kummu et al. (2012) came to the result that if we can half our food losses and waste, we can save up to 12% of the water consumption. Potentially, these saved resources could be used for food production to feed an additional one billion people.

4.3 Limitations and the way forward?

There are always certain limitations in studies like these. In this study, the water footprint values used are approximates, therefore some uncertainty will always be present when calculating them. Additionally, the origin of the imported food products was not taken into account when calculating the water footprints. Hence, to get more detailed and transparent results, all steps in the process from the origin of the food to the food consumption should be included in future studies.

In this study, only one definition for The Paleo and Mediterranean diet compositions was used, in reality these diets vary depending on the study. The diet compositions described in Jönsson et al. (2010) had a much lower energy intake than the recommended diet. However, in order to make all the diet scenarios comparable, their energy intakes were adjusted to correspond with the ADER. Naturally, using the original diet composition in Jönsson et al. (2010) would have resulted in smaller water footprints however this was not in-line with this research.

This study took into account the water consumption when changing diets. However, other variables, such as land use and greenhouse gas emissions may also change and impact the environment when adjusting eating habits. A way forward would be to look at other factors that are affected by a diet change, i.e. land use, greenhouse gas emissions, agriculture practices, or food production. An increased demand of certain food groups would require intensified production or more cropland to cultivate the products. These changes may lead to increase or decrease in water use, which affects the water footprint of the diet. Furthermore, studying a diet consisting of only domestic food products would be of interest and how it would affect the water consumption. By intensifying the production in the place of origin, in a country like Finland where we have plenty of resources, it would be possible to cut down the use of imported resources, such as water and land area. This would ease the pressure on already scarce regions.

5 Conclusion

In this study the water footprint of different diets in Finland were compared. My aim was to assess how the change of nutrient composition in the diet affects the blue and green water footprint. Although the Finnish diet is already rather water efficient, there is still a possibility to further reduce the water footprint by decreasing the consumption of animal products. At the same time, however, I found that other assessed diet scenarios – Paleo and Mediterranean diets– would increase the water consumption.

The Finnish diet has a high energy intake, so reducing the energy density would lower the water footprint. Additionally, replacing all animal products with plant-based products would decrease the total water footprint by as much as 18%. This comes in savings in green water, as the blue water footprint would increase because the production of plants requires more blue water than animal products.

The Paleo diet had a higher water footprint compared to all the other diets. This is due to the high amount of meat, oilseeds, fruits and vegetables in the diet, which affects both the green and the blue water footprint. The Mediterranean diet consumes a lot of cereals, fruits and vegetables and also plenty of meat, which resulted in a relative high water footprint as well. Our results thus indicate that both, the Paleo and Mediterranean diets, do not prove to be very sustainable in Finland even though they may result in health benefits.

This study increases the understanding on how the water footprint of a diet is affected in a country with high energy-intake and high content of animal products, both of which are predicted to increase on a global level. The Finnish water footprint of food consumption could be lowered by reducing the energy intake to follow the dietary recommendations as well as replacing animal products with plant-based products. At the same time, this would make it possible to improve food security and sustainable use of water in countries from where resources are imported.

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