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FINNISH WATER AND ITS GLOBAL LOGISTICS: A CASE STUDY ON FINLAND AND SOMALIA

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ABSTRACT

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In recent years, most of the world's organizations' attention has been directed towards how to provide access to safe drinking water for areas that lack access. This scarcity of water is claiming a lot of lives and leaving others disabled. In view of that, this thesis is intended to find out suitable sites for large scale water pumping in Finland. It will also suggest means for international transporting of Finnish water in large scale.

The thesis is drawn up mainly by means of theoretical research and analysis. It analyzed the severity of the scarcity of safe drinking water and the quality of Finnish groundwater. The thesis used a questionnaire and interviews in the processing of researching for the quality and the level of Finnish groundwater.

The thesis found out that there are a lot of good sites in Finland where groundwater can be pumped. Also, Finnish groundwater, in general, is to be considered as the best of quality. The possibility of transporting Finnish water on large scale is well assured.

Key words

Aquifer, container, groundwater, Logistics.

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1. INTRODUCTION

Water is life, as we say, for it has always been considered as one of the most essential resources. Water is very important for all living organisms and major ecosystems as well as human health, food production and economic development. It is difficult to purify water, expensive to transport and impossible to substitute. Water is indeed essential for life. People need water as much as they need oxygen. Without it life could not exist. Scientists have made it known that a person can live for weeks without food, but only for days without water (Hämäläinen, 2010). A person needs 4 to 5 gallons (15.14 to 18.93 liters) of water per day, to survive (World Water Organization, 2010).

Water is not evenly distributed all over the world. It means that it is in abundance somewhere, while it scarce some other place. From that point of view, world leaders have recognized that the world is facing a water crisis, due to the fact that most people in this world do not have access to clean drinking water. Lack of access to clean drinking water is causing a lot of water born diseases which claim millions of human lives. Inadequate access to clean drinking water also impacts about 900 million people. One of the leading death causes worldwide is water born diseases and absence of domestic water for sanitary. Of all the diseases, contaminated water accounts for 80% (WHO). Moreover, it also reinforces the obscene inequalities in life chances that divide rich and poor nations in an increasing prosperous and interconnected world, which divides people within countries on the basis of wealth, gender and other marker for disadvantage (Watkins, 2006).

There is more than enough water in the world for domestic use, for agriculture activities and industrial use of the whole mankind. The problem is that some people do not have access to it. The then UN secretary General Kofi Annan said, “Access to safe water is a fundamental human need and, therefore, a basic human right”. Upholding the right for water is an end in itself, and means for giving substance to the wider right in the Universal Declaration of Human Rights and other legally binding instruments. These are for example: the right of life, to education, to health and to adequate housing. Ensuring that every person has access to at least 20 liters of clean water each day to meet basic needs, and this is the minimum requirement for respecting the human right to water (Watkins, 2006).

In March 2005, on the world water day, a decade long initiative called “water for life” was started by the United Nations. The world health organization, UNICEF and the United Nations identified access to clean water as the single most important global crisis of the 21st century. The decade of 2005 to 2015 began a worldwide commitment to critical years to bring global attention to silence humanitarian – water for life. This made the millennium development goal target in 2015 – a test of humanity. The millennium development goals provide a benchmark for measuring progress towards the human right to water. There is now less than 5 years to go to the 2015 target date for achieving the millennium development goals.

The then UN Secretary General Kofi Annan, March 2005 said, “We shall not defeat tuberculosis, malaria, AIDS or any other infectious diseases that plague the developing world until we have also won the battle for safe drinking water”. It seems that the problem has been identified to be: “lack of access to clean water”. And that is where this project: “Finnish water and its global logistics” comes to the scene, to bring solution to the lasting problem of world water crisis, so as to help achieve the millennium development goal 7 Target 10 which says, “to halve the number of people who lack access to safe water by the year 2015. Today water crisis is not an issue of scarcity but of access. The world has the technology, the finance and the human capacity to remove the blight of water insecurity from millions of lives. Lacking are the political will and vision needed to apply these resources for the public good (Watkins, 2006).

1.1. Objective of the thesis

This thesis work is researching and combining data to create a suggestion of suitable water pumping sites in Finland. Concentration is on the area close to the cost line of Finland, that is, where there are both water resources and excellent logistics for Global transportation. As most interesting are considered sites, where there are only minor risks of the water body contamination, especially contamination caused by traffic accidents and industrial activities.

The thesis is also looking at the best possible way for economical transportation of Finnish water in large scale. All possible transportation modes are analyzed to find out the most economic and efficient way to transport water globally on a large scale. The thesis is uses Somalia as a case study, as a country which has water problems.

1.2. Thesis Methodology

The qualitative and quantitative means of research were jointly used to collect information and data to complete this thesis. As qualitative means of research, interviews were conducted to gather information. A couple of visits were made to various concerned company premises to interview their personnel, and also to collect some data.

Quantitatively, questionnaires were sent out to concerned companies to gather information and data as well. Some facts and figures in this thesis were also gathered from a secondary source, such as the internet, articles, eBooks, newspapers and material from libraries.

2. WORLD WATER SITUATION

According to world water council, 70% of the earth is covered by water, 97% of which is saltwater, and thus unsuitable for drinking. Agriculture uses 93% of our available water, industry uses 4% and only about 3% is used for domestic use. The world population is continuously on the increase. It was reported also by the world water council, that the world population tripled in the 20th century. At the same time the use of renewable water resources grew six fold, but the 3% water available for human use did not grow at all, and seems not to be growing even in the near future.

On the world water day, March 2005, it was said that in many parts of the world like in America and Europe, people take it for granted to turn on a tap for safe and clean water to drink, cook with and wash with run away. But each year, more than 1 billion people worldwide have no choice but to use potentially harmful sources of water for bathing, cooking and even drinking. This results in the death of more than 6000 children each day. More details can be found in Table 1 below.

On the webpage of Safe Water Organization, it was written that the global water consumption has risen almost tenfold since 1900, and in many parts of the world, including some areas of Australia, are now reaching the limits of their supply. World population is expected to increase by 45% in the next thirty years, whilst freshwater runoff is expected to increase by 10%. UNESCO has predicted that by 2020 water shortage will be a serious worldwide problem. One third of the world's population is already facing water problems in the form of water shortage and poor drinking water quality refer is Picture 1 below. These have lead to massive outbreaks of diseases, malnourishment and crop failures. Moreover, the degradation of the environment due to excessive use of water is costing the world billions of dollars (Safe water, 2005).

PICTURE 1.Woman fetches water to drink from a dirty well in Mandera (North Eastern Kenya) (adapted from Chimbi, 2011)

Finnish magazine “Tekniikan Maailma” once reported, “Vesi on elinehto, Maailmalla hyvälaatuisesta vedestä on pulaa. Enemmän kuin joka kuudes ihminen maapallolla kärsii turvallisen käyttöveden puutteesta”, meaning: Water is essential for life, there is a lack of good quality water in the world. More than one sixth people on earth suffer from a lack of safe water (Hämäläinen, 2010).

2.1. How lack of access to water affects health

The health of human depends on clean and sufficient amount of water and safe sanitation (World Vision, 2006). Anywhere, where there is a lack of water sanitation and health there are also problems. In the developing countries, where clean water is often a problem, a lot of people suffer from water-related diseases. These diseases can be either infectious, such as cholera and malaria, or non-infectious such as flourisis, from high fluoride levels. Water-related diseases come in contact for instance in the following ways:

- **Water-borne diseases** which are caused by drinking water contaminated by faeces. Such diseases include diarrhoeal infections, cholera, typhoid, poliomyelitis and hepatitis A.
- **Water-related diseases**: these diseases are caused by insects that feed or breed in water, like flies and mosquitoes. The disease they cause, includes malaria (400 million people suffer each year), Onchocerciasis (river blindness, 17 million suffer each year).
- **Water-based diseases**: There are parasites which spend part of their life cycle in organisms living in water. These include guinea worm (dracunculiasis): this affects about 100 000 people each year, who drink infected water. Another example is the schistosomiasis (bilharzias), which affects about 200 million people each year after being in contact with infected water.
- **Water washed (water scarce) diseases** caused by poor hygiene and skin or eye contact with contaminated water; diseases include scabies, trachoma, and flea, lice and tick-borne diseases.

2.2. Factors affecting peoples' access to water and its use

The issue of lack of access to safe drinking water has been a real issue in this world. Water is not evenly distributed in this world. Some countries have water in abundance while others do not have any. This problem is due to a number of factors.

2.2.1. Physical and Demographic factors

There is more than enough water in the world, but because of climates and geographic, the water resources are unevenly distributed among and within countries. Where there are a large number of people sharing limited supplies of water especially in growing cities, some people cannot obtain an adequate amount of water. Some countries have only few water bodies but large population and likewise (World Vision, 2006).

However, by systematical research, water can be found in places, where it is not expected to be found. For instance, large water bodies have just recently been discovered under the Sahara desert (Eco New, 2012).

2.2.2. Economic and Geopolitical factors

It can be clearly seen that the amount of water, which people use, is directly related to how easy for them it is to obtain it, and how affordable it is to them. An average American individual uses 100 to 176 gallons ($0.38m^3$ to $0.67m^3$) of water at home each day and the average African family uses about 5 gallons ($0.02m^3$) of water each day (World Water Organization, 2010). Not all countries extract crude oil, but every Government makes sure there is enough crude oil in the country for use. Most of the major rivers in the world flow through several countries, so those living downstream depend on the good will users upstream. For example Israel has faced some water problems, because some of its neighbouring countries have their turned natural river downstream, most probably merely for political reasons. However, this case has turned to an advantage to Israel, as they had to find out new ways for accessing to water. Most of Israeli water need is nowadays covered by water extracted from the sea water. Israel should be considered as an excellent example for turning a deserted land, in some 50 years of time, into a fertile area of agriculture, by means of artificial watering (Eco New, 2012).

TABLE 1 Summary Statistics on Deaths and Disability Related to Water, Sanitation and Hygiene in 2002

DISEASE OR INJURY	DEATH					
	Total		**Children 0-14 years**		**Developed countries**	**Developing countries**
Population (´000)	6,224,985		1,830,140		1,366,867	4,858,118
	(´000)	%[b]	(´000)	%[b]	(´000)	(´000)
Total deaths or DALYs	57,029		11,945		13,430	43,599
Total WSH-related	3,575		3,011		73	3,503
% of total death or DALYs	6.3%		25%		0.5%	8.0%
Diarrhoeal diseases [c]	1,575	42.6	1,370	45.5	15	1,507
Intestinal nematoge infections[d]	12	0.3	8	0.3	0	12
Malnutrition (only PEM)[c,e]	71	2.0	71	2.4	0	71
Consequences of malnutrition[c,e]	792	22.1	792	26.3	9	783
Trachoma [d]	0	0.0	0	0.0	0	0
Schistosomiasis [d]	15	0.4	0	0.0	0	15
Lymphatic filariasis [d]	0	0.0	0	0.0	0	0
Subtotal water supply, sanitation and hygiene	2,413	67.5	2,241	74.4	24	2,389
Malaria [e]	526	14.7	482	16.0	0	526
Onchocerciasis [e]	0	0.0	0	0.0	0	0
Dengue [e]	18	0.5	14	0.5	0	18
Japanese encephalitis[e]	13	0.4	7	0.2	0	13
Subtotal water resource management	557	15.6	502	16.7	0	557
Drownings [e]	277	7.7	106	3.5	33	244
Subtotal safety of water environments	277	7.7	106	3.5	33	244
Other infectious diseases[e,f]	328	9.2	162	5.4	15	312

(Continues)

TABLE 1. (Continues)

DISEASE OR INJURY	DALY[a]					
	Total		**Children 0-14 years**		**Developed countries**	**Developing countries**
Population (´000)	6,224,985		1,830,140		1,366,867	4,858,118
	(´000)	%[b]	(´000)	%[b]	(´000)	(´000)
Total deaths or DALYs	1,490,126		544,534		213,574	1,276,552
Total WSH-related	135,748		117,789		1,861	133,887
% of total death or DALYs	9.1%		22%		0.9%	10%
Diarrhoeal diseases [c]	52,460	38.6	48,830	41.5	648	51,812
Intestinal nematoge infections[d]	2,948	2.2	2,884	2.4	3	2,945
Malnutrition (only PEM)[c,e]	7,104	5.2	7,104	6.0	83	7,021
Consequences of malnutrition[c,e]	28,475	21.0	28,475	24.2	181	28,294
Trachoma [d]	2,320	1.7	13	0.0	0	2,319
Schistosomiasis [d]	1,698	1.3	560	0.5	1	1,697
Lymphatic filariasis [d]	3,784	2.8	1,211	1.0	1	3,783
Subtotal water supply, sanitation and hygiene	98,789	72.8	89,077	75.6	918	97,871
Malaria [e]	19,241	14.2	17,984	15.3	11	19,230
Onchocerciasis [e]	51	0.0	10	0.0	0	51
Dengue [e]	586	0.4	512	0.4	0	586
Japanese encephalitis[e]	671	0.5	459	0.4	0	671
Subtotal water resource management	20,550	15.1	18,965	16.1	12	20,539
Drownings [e]	7,871	5.8	3,845	3.3	736	7,135
Subtotal safety of water environments	7,871	5.8	3,845	3.3	736	7,135
Other infectious diseases [e,f]	8,538	6.3	5,902	5.0	196	8,343

Notes to explaining abbreviations and letters in Table 1 above:

DALY: **disability-adjusted life year**; PEM: protein-energy malnutrition; WSH: water, sanitation and hygiene. Note that number may not add up as a result of rounding.

a. DALYs are a weighted measure of deaths and disability.

b. Percentage of all deaths/DALYs attributable to WSH-related risks.

c. Data further validated by Comparative Risk Assessment method.

d. Comparative Qualification of Health Risks.

e. Not a formal WHO estimate, data based on literature review and expect survey.

f. Not attributable to one group alone

3. FINNISH WATER AVAILABILITY FOR EXPORT

A UN report on the world's water situation says that the best water in the world is to be found in Finland. A report published at the Third World Water Forum in Kyoto listed 122 countries in order from the best to the worst in terms of the quality of their water. After Finland came Canada, New Zealand, Great Britain and Japan (World Water Council, 2003).

According to the Ministry of Agriculture and Forestry, Finland is one of the top countries in the world in regard to the amount and quality of water. Finland has enough water for the needs of all their citizens, and functioning water services cover the whole country. Lakes, ponds, rivers and brooks constitute 10% of the total surface area. The Table 2 below shows the number of lakes and river basins in Finland. There are also about 450 large-scale dams, of which 380 are water dams and the rest are wastewater dams (Ministry of Agricultural and Forestry, Finland, 2009).

TABLE 2. Lakes and River Basins Table (Ministry of Agricultural and Forestry, Finland)

Number of lakes	Area km^2	Number of main river basins	Area km^2
47	>100	2	>50,000
279	10 – 100	7	10,000 – 50,000
2283	1 – 10	1	5,000 – 10,000
53423	0.01 – 1	26	1,000 – 5,000
		14	500 – 1,000
		24	200 – 500

Regional variation in the quantity and supply of water is great. As an example of a water-rich area in Finland, is the small 12 000 inhabitant commune, called Liperi, located in North Karelia, Eastern Finland. The total communal area of Liperi is 1161 km^2, of which 421 km^2 is covered by water, such as clean watered lakes, and having more than 1000 km of water line length on the communal area (Liperi Municipality).

Water resources per inhabitant in Finland is good, especially in the eastern and northern parts of the country, while in the coastal regions of the western and southern Finland with the highest population density there are fewer sources for the abstraction of high-quality drinking water (Ministry of Agricultural and Forestry, Finland, 2009).

PICTURE 2. Clean surface water in Finland (Picture by Marko Sallinen)

3.1. The standard quality of Drinking Water in Finland

According to the Finnish law of health protection (chapter 5), Finnish drinking water is defined as, “all water that is meant for drinking, food preparation, or other domestic purposes regardless of whether the water is transmitted through the distribution network, tanks, bottles, or containers; and all water that is used in the food industry for processing, storage and entry on the market” (Heath protection Act 763/1994). Natural mineral water for medical purposes is not meant for drinking. Drinking water should also be otherwise suitable for use and it should not cause harmful erosion or lead to the formation of harmful deposits in water pipes or channel device.

The EU drinking water directive 98/83/EC (Council of EU 1998) tells the minimum requirements of the sanitary quality of drinking water within the EU. The directive aim is to protect consumers of drinking water within the European Union and to make sure that water is aesthetically clean and without unpleasant taste, odour or colour. The directive listed 48 microbiological and chemical parameters which should be regularly monitored. The Finnish Ministry of Social Affairs and Health defined the requirements and recommendations for quality of drinking water in Finland (Health Protection Regulation, 2000). The regulation is based on the drinking water directive and concerns all water that is:

- Delivered to household water use by at least $10m^3$ per day, or at least 50 people.
- Used in food business products intended for human consumption or use in the manufacture, processing, storage and placing on the market.
- Distributed as household water use as part of any public or commercial activity.

Drinking water in Finland means cold water, and the quality is monitored by the Municipal Health Authority which takes water samples from flushed water (Health Protection Act section 20).

The Finnish regulations also define the minimum requirements and it details the quality related demands and guide values for microbiological, chemical, technical and radioactive parameters which are listed in the Table 3 and 4 below. The quality requirement of water should be monitored regularly in the distribution network at the point where sample is taken from the consumers tap. The Finland decree on drinking water has tighter limit values set for chloride (Cl^-) and Sulphate (SO_4^{2-}) than the drinking water directive in order to prevent corrosiveness of drinking water (Table 3, note [1] and [3]) Moreover, the Finland decree on drinking water has a limit value for chlorophenals through these compounds, which are not included in the drinking water directive.

3.2. The necessary authorization for groundwater extraction in Finland

Under the Water Act 2000, groundwater abstraction refers to wells or other institutions from which the groundwater is drained, pumped, or otherwise taken for commercial use, industries, or for any other purpose (Water Act chapter 9 section 5). Under the regulation, no substance shall be deposited in or energy conducted to a place or handled in a way that it leads to negative health effects, or otherwise violates the public or private good.

To abstraction groundwater environmental work permit needed. The level of groundwater at the area is considered. The groundwater is unalterable under the water law chapter 1 section 18. The water taking should be designed for minimum of 250m^3 per day. For Environmental Agency to grant a permit for groundwater extraction, the condition that measures the benefits of resulting injury, damage or other loss of much greater interest are also considered. According to chapter 9 section 8 of the water law, permit shall be refused if the abstraction will affect residences or business conditions of the deterioration of access to water suppression or interference with a large area or significant adverse changes in the natural proportions.

A number of terms for permit may be related to the following:

- Water intake amount
- Use
- Stability of the authorization and validity of the abstraction
- Place in idea and the operations on pumping area
- Surveillance
- Injury replacement
- Business hour and disclosure obligation

TABLE 3. The requirements and guide values defined in the regulation of Social Affairs and Ministry of Health Finland 461/2000

Parameter	Maximum concentration	Note
Microbiological qualities		
Escherichia coli	0cfu/100 ml	
Enterococcus	0cfu/100 ml	
Chemical qualities		
Acrylamide	0.10µg/l	1
Antimony (Sb)	5.0µg/l	
Arsenic (As)	10µg/l	
Bensene	1.0µg/l	
Benso(a)pyrene	0.010µg/l	
Boron (B)	1.0mg/l	
Bromate (BrO_3^-)	10µg/l	2
Cadmium (Cd)	5.0µg/l	
Chromium (Cr)	50µg/l	
Copper (Cu)	2.0mg/l	3
Cyanides	50µg/l	
1,2-Dichloroethane	3.0µg/l	
Epichlorohydrine	0.10µg/l	1
Fluoride (F^-)	1.5mg/l	
Lead (Pb)	10µg/l	3
Mercury (Hg)	1.0µg/l	
Nickel (Ni)	20µg/l	3
Nitrate (NO_3^-)	50mg/l	4
Nitrate nitrogen (NO_3-N)	11.0mg/l	
Nitrate (NO_2^-)	0.5mg/l	4
Nitrate (NO_2-N)	0.15mg/l	
Pesticides	0.10µg/l	5,6
Pesticides total	0.50µg/l	5
Polycyclic aromatic hydrocarbons	0.10µg/l	7
Selenium (Se)	10µg/l	
Tetrachloroethene and trichloroethene total	10µg/l	
Trihalomthanes total	100mcg/l	2,8
Polymers of vinyl chloride	0.50µg/l	1
Chlorophenols total	10µg/l	9
Indicator variables		
Aluminium (Al)	200µg/l	
Ammonium (NH_4^+)	0.50mg/l	
Ammonium (NH_4-N)	0.40mg/l	
Chloride (Cl^-)	250mg/l	10,11
Manganese (Mn)	50µg/l	
Iron (Fe)	200µg/l	

(Continues)

TABLE 3. (Continues)

Sulphate (SO_4^{2-})	250mg/l	10,12
Sodium (Na)	200mg/l	
Oxidizability (COM_{Mn}-O_2)	5.0mg/l	13
Clostridium perfringens (including spores)	0cfu/100ml	14
Coliformic bacteria	0cfu/100ml	
Plate count (22°C)	no unusual changes in	
pH	6.5 – 9.5	10
Electrical conductivity	less than 2500µS/cm	10
Turbidity	acceptable to users or unusual changes in	15
Colour	unusual changes	
Smell and taste	unusual changes	
Total organic carbon (TOC)	unusual changes	16
Radioactivity		17
Tritium (^3H)	100Bq/l	
Total indicator dose	0.10mSv/a	

Below is explanation of the note in Table 3:

1 Concentration is calculated according to the maximum amount released or dissolved from the used polymer stated in the product description.

2 Lower concentrations must be sought without weakening the disinfection efficiency.

3 Sample from user's tap, concentration calculated to be analogous to weekly average.

4 Maximum concentration of nitrite in water living waterworks is 0.10mg/l. (conc. of nitrate/50) + (conc. of nitrite/3) must not exceed the limit value of 1.

5 Organic insecticides, herbicides, fungicides, nematocides, acaricides, algaecides, and rodentacides; organic antislime agents; other equivalent products as well as their metabolites, degradation products and reaction products.

6 Limit value for aldrin, dieldrin, heptachlorine, and heptachloroepoxide is 0.030µg/l.

7 Benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(ghi)perylene, indan-(1,2,3-cd)-pyrene.

8 Chloroform, bromoform, bromide chloromethane, dibromochloromethane

9 Tri-, tetra- and pentachlorophenol

10 Water must not be corrosive

11 To prevent corrosion of pipe materials, the concentration should be below 25 mg/l

12 To prevent corrosion of pipe materials, the concentration should be below 150 mg/l

13 Not necessary needed to be measured if TOC is measured

14 Measured if raw water is surface water

15 Turbidity of water leaving surface-water waterworks should be below 1 NTU

16 No need to measure if oxidizability (COD_{Mn}) is determined and the amount of distributed water is below 10000m^3/d

17 Total indicative dose of tritium and radioactivity does not need to be measured if earlier studies show these values to be clearly below the limit values. Radon, its degradation products, tritium or postassium-40 (^{40}K) are not included in the total indicative dose.

TABLE 4. Bottles or containers water quality standard recommendation (The values that differ from Table 3)

Parameter	Maximum concentration	Note
Microbiological qualities		
Escherichia coli	0cfu/250ml	
Enterococcus	0ml of pmy/250	
Pseudomonas aeruginosa	0ml of pmy/250	
Plate count (22°C)	100cfu/ml	
Plate count (37°C)	20cfu/ml	
Recommendation for quality		
Coliformic bacteria	0ml of pmy/250	
pH	4.5 – 9.5	

According to the regulation, bottle water for sale must meet the standard recommended in Table 4 above.

3.3. Finnish groundwater

Groundwater is mostly relied upon in Finland as source of potable water. Groundwater accounts for about 60% of the water distributed in Finland according to Finnish Environmental Institute. There are more than 2300 water intake plants serving more than 10 people and 600000 wells, each serving one single household or a summer cottage (Korkk-Niemi 2001, 20, 98).

Groundwater area mapping was conducted in early 1990’s by the Finnish Environmental Institute (Britschgi and Gustafsson 1996). The research found out 7141 groundwater areas. It was indicated that groundwater is capable of supplying Finland water in the future. At present, only about 10% of the estimated total yields of the mapped groundwater reserves in daily use.

The department of geology in University of Helsinki found out that area where aquifers are well know have high groundwater storage potential (Salonen, 2002). The quality of water improves a sit filters through the soil (Finnish Environment Institute 2009).

3.3.1. Finnish Aquifer

Aquifers are natural filters that trap sediment and other particles (like bacteria) and provide natural purification of the groundwater flowing through them. Like a coffee filter, the pore spaces in an aquifer’s rock or sediment purify groundwater of particulate matter (the ‘coffee grounds’) but not of dissolved substances (the ‘coffee’). Also, like any filter, if the pore sizes are too large, particles like bacteria get through. This can be a problem in aquifers in fracture rock (Idaho). Example of aquifer is shown in Figures 2 and 3 below.

When water passes through the aquifers, it is obvious that not only the filtering effect cleans the water, but also the natural biological / bacteriological purification procedure inside the sediments.

According to Finnish Environment Institute, almost 6350 aquifers have been mapped and classified in Finland. More than half of the aquifers are exploitable for water supply. It is estimated that Finland's aquifers are replenished by an average of almost 5.4 million cubic meters of water a day. Finland extracts around 0.7 million cubic meter of groundwater a day (Finnish Environment Institute 2009).

The main aquifers in Finland are located in the Salpausselkä ice-marginal and in the esker formations. The Finnish sand and gravel aquifers are shallow and unconsolidated, which were formed during the Quaternary period, mainly during the Weichsel Ice Age or thereafter and are results of various geological processes. The retention time of groundwater is generally quite short. The aquifers are small due to the topography of the crystalline bedrock and the thinness of the unconsolidated sediments. Aquifer situated in larger eskers or ice-marginal deposits are wider and deeper and the retention time is longer.

There is one aquifer which is one of the delineated Water Framework Directive (WFD) groundwater bodies and it belongs to a preliminary defined group of groundwater bodies as shown in Table 5 and Figure 1. The groundwater body is situated in southern part of Finland. The groundwater body is part of the I Salpausselkä ice-marginal formation (Marja-Leena and Juhani, 2006).

TABLE 5. The aquifer in the preliminary group groundwater bodies (Marja-Leena and Juhani, 2006)

Aquifer name	Total area of the aquifer	Recharge area	Estimated recharged amount of groundwater
	(km^2)	(km^2)	(m^3/d)
Lahti	40,36	19,95	30000
Renkomäki	6,19	3,45	2500
Kolava	3,05	2,18	1200
Kukonkoivu-Hatina	61,09	48,84	45000
Salpakangas	11,5	8,37	6500
Villähde	3,25	1,42	900
Nastonharju-Uusikylä A	8,4	6,2	4000
Nastonharju-Uusikylä B	11,87	5,95	3800
Total	145,71	96,36	93900

Although Finland has plenty of aquifers, these resources are not distributed evenly across the country. The most significant aquifers are in large moraine and esker made of sands and gravels deposited at the end of the last Ice Age approximately 10,000 years ago. Figure 4 is map of Finland showing numerous numbers of ridges (which have aquifer in them). Water is typically clean, well oxygenated and often also easily extractable (Finnish Environment Institute, 2009). The aquifers in Finland's glacial deposits rank in quality among the best reserves of groundwater in the world.

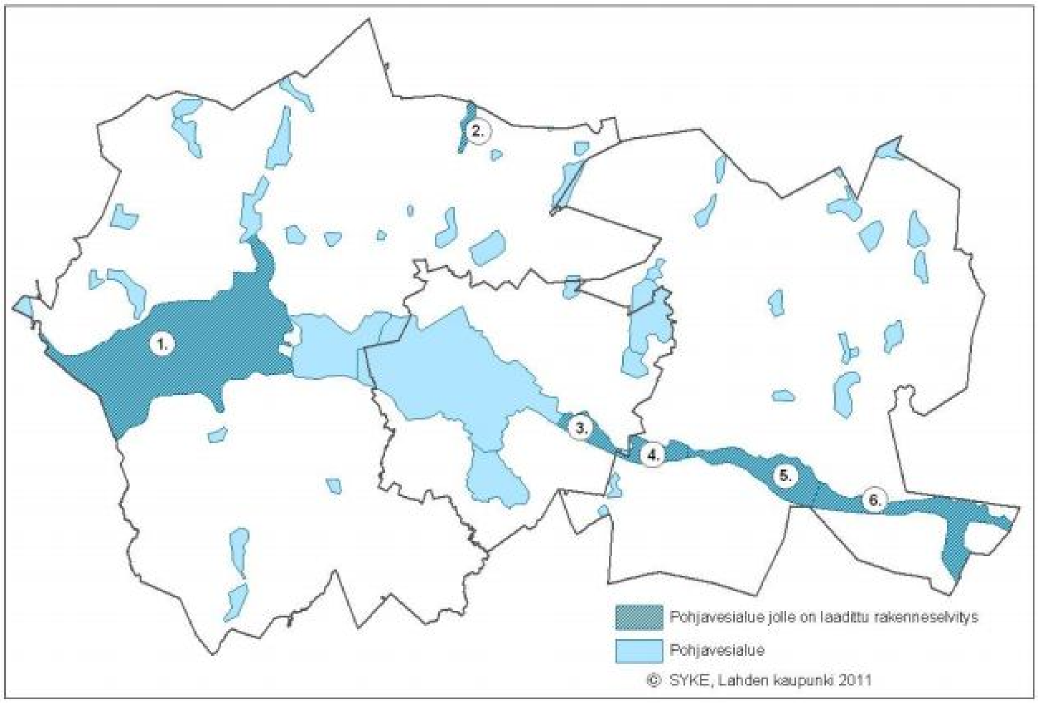


FIGURE 1. Groundwater areas (adapted from Lahti Region Environmental Services)

The groundwater areas (Figure 1) have been mapped in the structural stuidies: 1. Kukonkoivu-Hatsina 2. Paimelanvuori 3. Kolava 4. Villähde 5. Nastonharju-Uusikylä A 6. Nastonharju-Uusikylä B (Lahti Region Environmental Services)

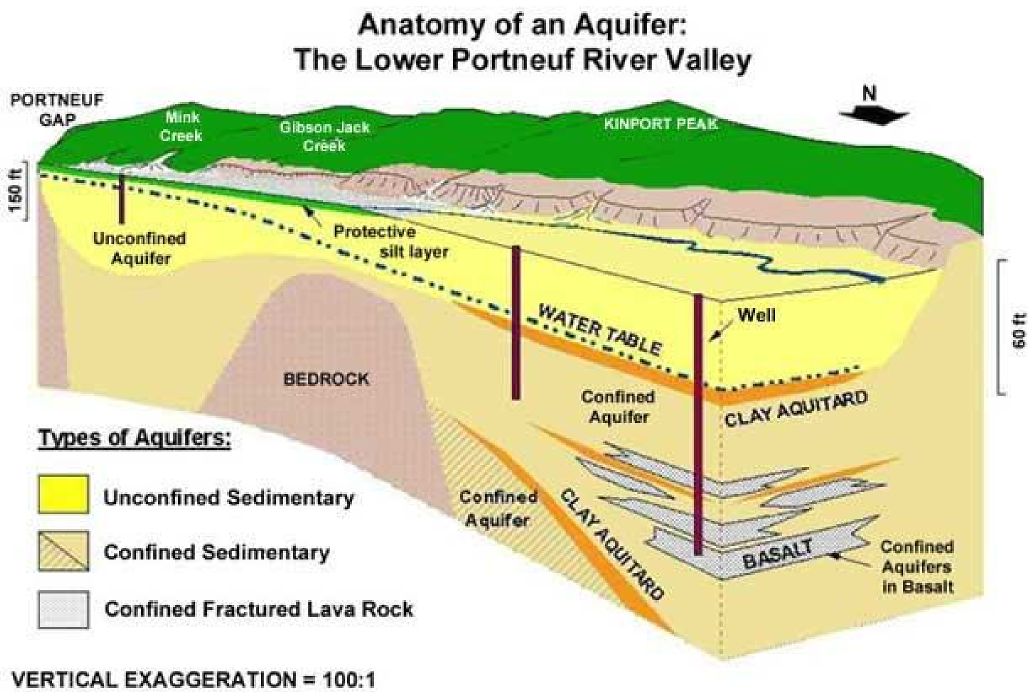


FIGURE 2. The anatomy of an aquifer (adapted from Digital Atlas of Idaho)

According to Figure 2, on aquifer is made of layers of unconfined sediment, confined sediment and confined fractured lava rock. Clay particle and other mineral surfaces in an aquifer also can trap dissolved substance or at least slow them so they don't move as fast as water percolating through the aquifer (Idaho).

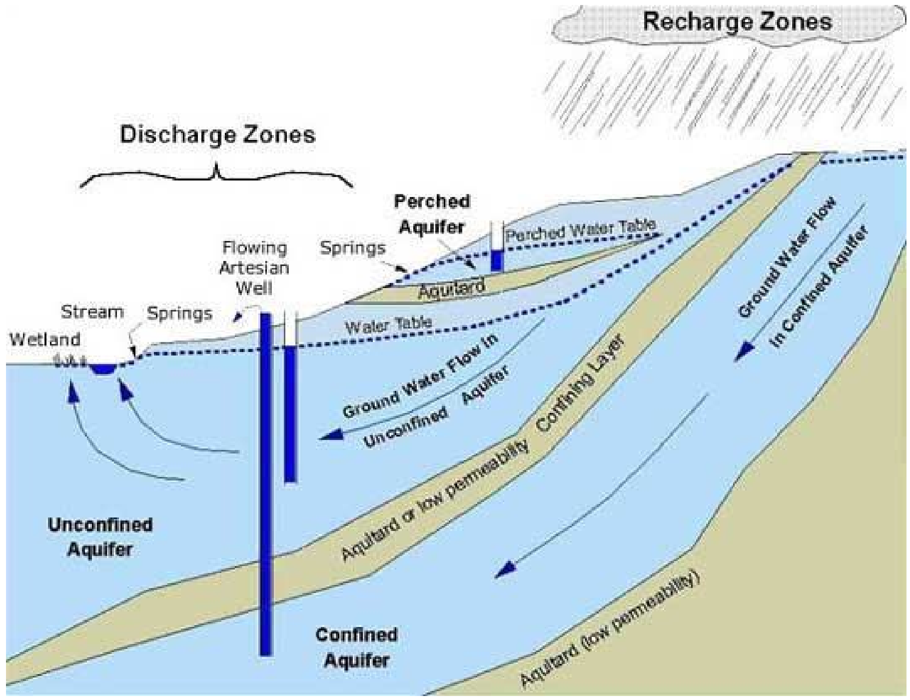


FIGURE 3. How aquifer works (adapted from Digital Atlas of Idaho)

The water passes through the pores of the sediment for purification as shown in Figure 3. There are three different type of aquifers shown: confined, unconfined, and perched. Recharge zones are at higher altitudes but can occur wherever water enters an aquifer, such as from rain, snowmelt, river and reservoir leakage or from irrigation. Discharge zones can occur anywhere but according to Figure 3, discharge occurs in springs near the stram, wetlands at low altitude and also from wells and high-altitude springs (Idoho).

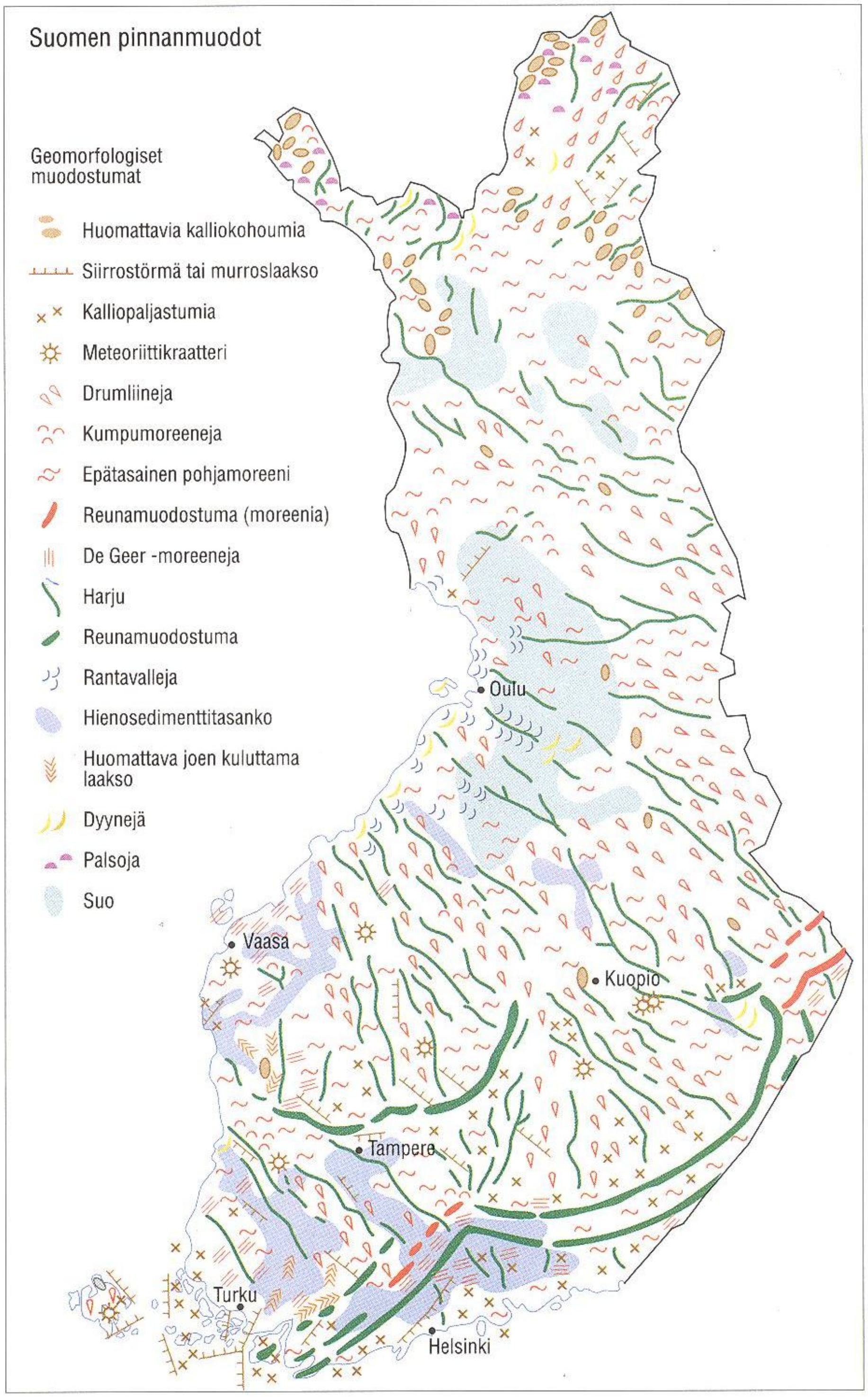


FIGURE 4. Finnish topography, concentration is on 'harju' which means ridge in English (adapted from Suomenmaa, Zetterberg, 1997, 11)

3.4. Market and requirements in Somalia

According to UNICEF, access to safe water is a significant problem in Somalia. It has been estimated that 65 percent of the population does not have reliable access to safe water throughout the year. It has contributed to cholera endemic and claims hundreds of lives annually. The high rate of illness and death in Somalia is as a result of the inability to access safe drinking water. The situation is compounded by erratic rainfall patterns that produce both drought and flooding (UNICEF).

A press at Nairobi on Friday 28 January, 2011 said that Somalia is facing a severe water shortage, following the failures of the short rains. Food Security and Nutrition Analysis Unit (FSNAU) Chief Technical Advisor, Grainne Moloney said in the press release that, poor rains are normal part of the climatic seasonal pattern in Somalia. He continues that even one poor rainy season is enough to put a poor household into crisis (FSNAU, 2011).

On September 8, 2011 at 11:39 AM, people were queuing for clean drinking water from a truck at Mogadishu the largest city in Somalia, and the nation’s capital. Report shows that more than 13000 people were reached every day (Lovick, 2011), see picture below.

PICTURE 3. Showing people queuing for drinking water in Mogadishu on 8^{th} September, 2011 at 11:39 AM (Mercy Corps, 2011)

PICTURE 4. Somali boys fetch water from a puddle in the sprawling Dadaab refugee complex in Kenya. Picture by Tony Karumba (Miller, 2011)

3.5. Comparison of transport modes

A long term success of every organization depends on its ability to deliver products to customers and this is precisely the role of the logistics. Logistics includes all the activities that are needed to ensure a smooth journey of materials from original suppliers, through supply chain and to final customers. The broad function of logistics embraces a series of related activities, inventory management, materials handling, order processing, distribution recycling, location decisions, information processing and other related functions (Waters 2007).

In the case of transportation, the modes, format and price are the decision area (Bozarth and Handfield, 2008). The mode of transportation strengths and weakness according to Bozarth and Handfield are explained below.

Highway mode

Strengths:

- Flexibility to pick up and deliver where and when needed
- Often the best balance between cost/flexibility and delivery reliability/speed
- Can deliver straight to the customer (increasing)
- Can be available 24/7

Weaknesses:

- Not the fastest
- Not the cheapest
- Not the best mode in ecological point of view

Water mode

Strengths:

- Highly cost effective for bulky items
- Works best for high weight-to-value items
- Most effective when linked into multimodal system
- Most environmental friendly of all modes

Weaknesses:

- Limited location
- Relatively poor delivery reliability/speed
- Often limited operating hours at docks

Air mode

Strengths:

- Quickest delivery over longer distances
- Can be very flexible when linked to highway mode
- Works best for low weight-to-value items

Weakness:

- Often the most expensive, particularly on a per pound basis
- Not good for environment

Rail mode

Strengths:

- Highly cost effective for bulky items
- Can be most effective when linked into multimodal system
- Most environmental friendly of all the modes on land

Weaknesses:

- Limited location but better than for water
- Better delivery reliability/speed than water

(Bozarth and Handfield, 2008)

Pipeline (J.R Stock & D.M Lambert)

This is where products like natural gas, crude oil, petroleum products, water, chemicals and slurry products are used to transport. The flow of product is monitored and controlled by computers. Losses and damages are extremely rare. Climatic conditions have minimal effects. Not labour-intensive and strikes or employee absences have little effect on them. However, building and maintaining a pipeline is a significant cost (Stock & Lambert, 2001, 328).

Multi mode

To exploit the strength of each mode, the technology of multi-mode should be used; this is where transport involves two or more different mode. Example:

Track → **Train** → **Ship** → **Track**

Price is also one important aspect that should be considered in transportation. According to J. R. Stock & D. M. Lambert, transport is a variable expense of business and has impact of actual price of goods and services. Inefficient and excess cost incurred in transportation will cause upward pressure on price. Transportation is one of many factors to be considered when making decisions on facility locations. Materials like sand and coal transportation cost can be 50% of the price (Stock & Lambert, 2001, 314).

3.6. Freight Rate

Sea freight is generally divided into regional shipping routes and deep sea shipping routes. Sea freight is the cheapest option for international movements (Giant logistics Ltd). The map below (Figure 4) shows a stylized schematic of the major deep sea shipping routes.

FIGURE 4. The major deep sea routes (adapted from Giant logistics Ltd)

Train freight rate depends on distance and number of containers. The VR transpoint makes contracts with customers based on collection point, delivery point, and the kind of container, weight, number to be sent and date of delivery (Sirvio, 2012).

The road freight rate also depends on the weight, dimensions of container, collecting postcode and delivery postcode in Finland (BarringtonFreight).

4. RESULT AND DISCUSSIONS

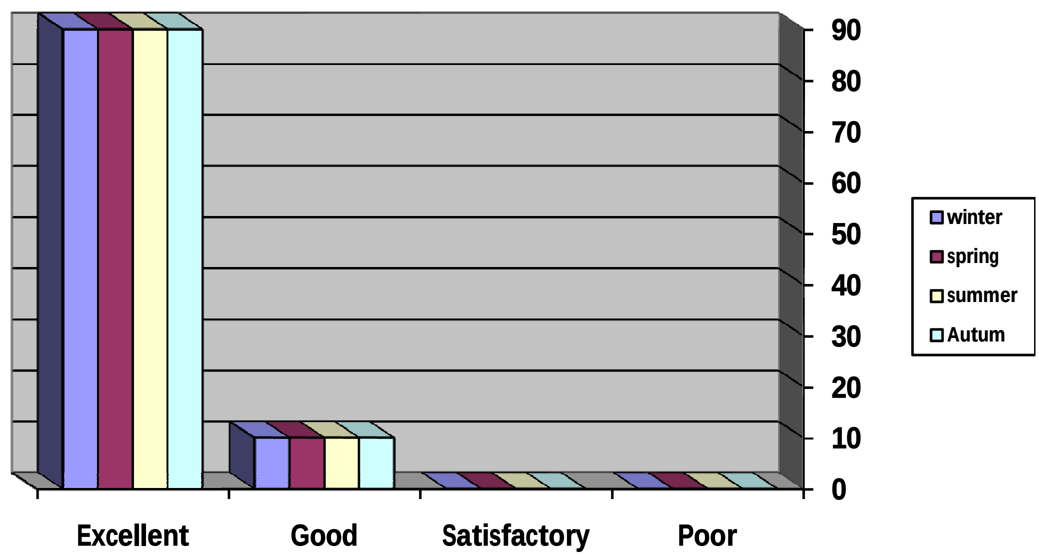
The thesis used interviews and questionnaire to collect data for the Finnish groundwater analysis. The questionnaire was used to find out the total capacity, free capacity, price and the quality of Finnish groundwater. The following analyses show the response of the data collected by the questionnaire, appendix 1.

4.1. Water quality

As required, the quality of Finnish water is tested at regular intervals. The quality of the water must be in relation to that of the standard, showed in Table 3 and 4. Using the required standard as a reference, the questionnaire graded quality as excellent, good, satisfactory and poor. It must be noted, that the term "poor" would still be acceptable according to the standard, which means that despite the poor-classification, the water is still drinkable. From the data collected, excellent quality shows a higher percentage and it is represented graphically in Graph 1. The result cuts across all annual seasons: that is winter, spring, summer and autumn, for noticing the possible risks of seasonal varying in the water quality. In Finland the water quality is, on some sites, temporarily reducing during for example in spring and early summer. This is caused by the melting snow, and thus strongly increasing water flows on the ground, ditches, rivers, etc. Especially the surface waters, such as waters of the lakes, are disturbed during this time. On some rare sites even the ground water can be disturbed, causing seasonal colour or odour changes in the natural ground water. This is happening for example on sites where:

- the ground water is very near to the surface, and
- where there will be great amounts of melting waters,
- and where the soil material is of a certain type, which is more vulnerable for this kind of a threat

The result proves the point that Finnish water is indeed the best in the world as was said at the Third World Water Forum in Kyoto, March 2003 according to World Water Council. 90% of the data collected shows excellent quality of water and 10% shows good. The quality of water is remaining the same throughout the year. The quality is not affected by the seasonal changes, in regard to the sites, where the questionnaires were filled and returned.



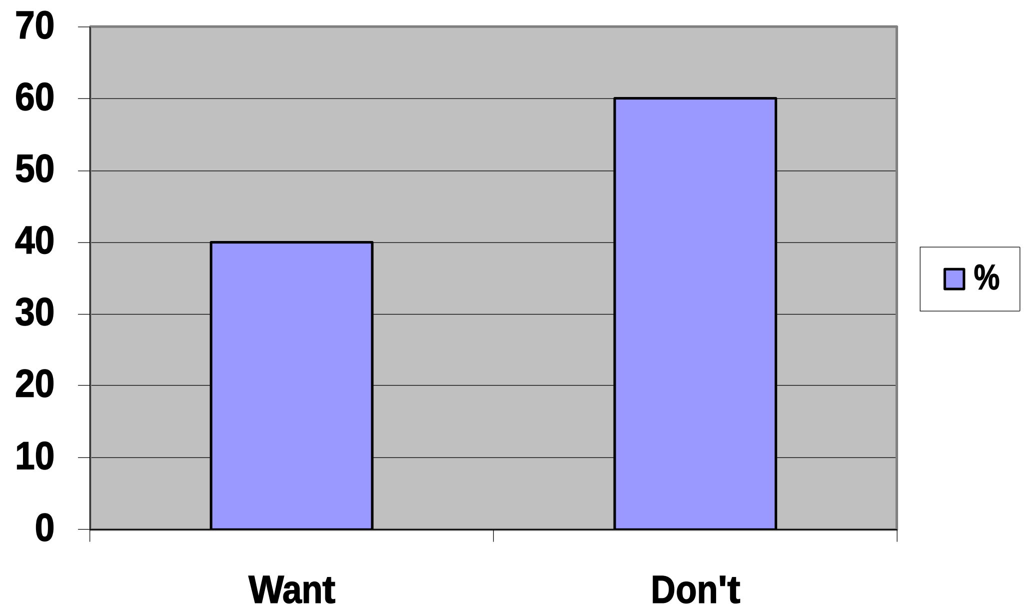
GRAPH 1. Quality of Finnish groundwater, according to the questionnaire

4.2. Companies' interest in seeking new clients

The questionnaire also wanted to find out the number of groundwater extracting companies in Finland that are seeking new clients.

Most companies are seeking for new clients/customers in order to expand their market share. However, this case is not always relevant in Finnish ground water business.

It was seen that most of the groundwater extracting companies in Finland produce the water for municipalities/communities, and therefore do not need new clients. This result is represented in Graph 2 below.



GRAPH 2. Water extracting companies who, according to the questionnaire, want or do not want to find new clients

4.3. Price of groundwater in Finland

Price of the Finnish groundwater was also one of the objectives of the questionnaire. Groundwater prices in Finland differ from municipality to municipality, based on the collected data. Finding out the reasons for the difference is not clear, and it could be a subject to another research. However, the average price according to data collected is €1.21/m^3. According to the questionnaire, the highest price was €1.46/m^3 and the lowest price €0.87/m^3.

4.4. Pumping site

The thesis resulted in finding the regional area of Lahti (a city located in the Southern Finland) as a suitable groundwater pumping site. The area is a part of the large quaternary ice-marginal formation, which is considered to deposit between 10.700 – 10.900 years ago, during the Younger Dryas times. The choice of the site was made on the basis of the following:

- Lahti regional area has one of the best aquifers in Finland
- The total area of Lahti's groundwater body is approximately 40 km^2 and the amount recharged in it, is approximately: daily 30.000 m3 (30.000.000 liters/day)
- In addition to the previous, on the Lahti area, there appears some bank-infiltration, which increases the amount of groundwater.
- Acts taken to protect the ground water is a major priority of the city of Lahti. This is because Lahti is situated near to one of Finland's largest areas of groundwater.
- Highway 12 groundwater protection on the planned prtection area is altogether about **15 km** and highway 4 about **8 km.** (Figure 5). Other highways on Lahti area are not protected. On Lahti region's ground water area there is about 20 km of highway, without protection.
- Lahti is located along a busy railway and at the junction of several highways. This gives excellent transportation facilities.
- Lahti is located only about a 100 km drive from e.g. Helsinki, where a major sea harbour is located. This is less than an hour of drive along the highway.

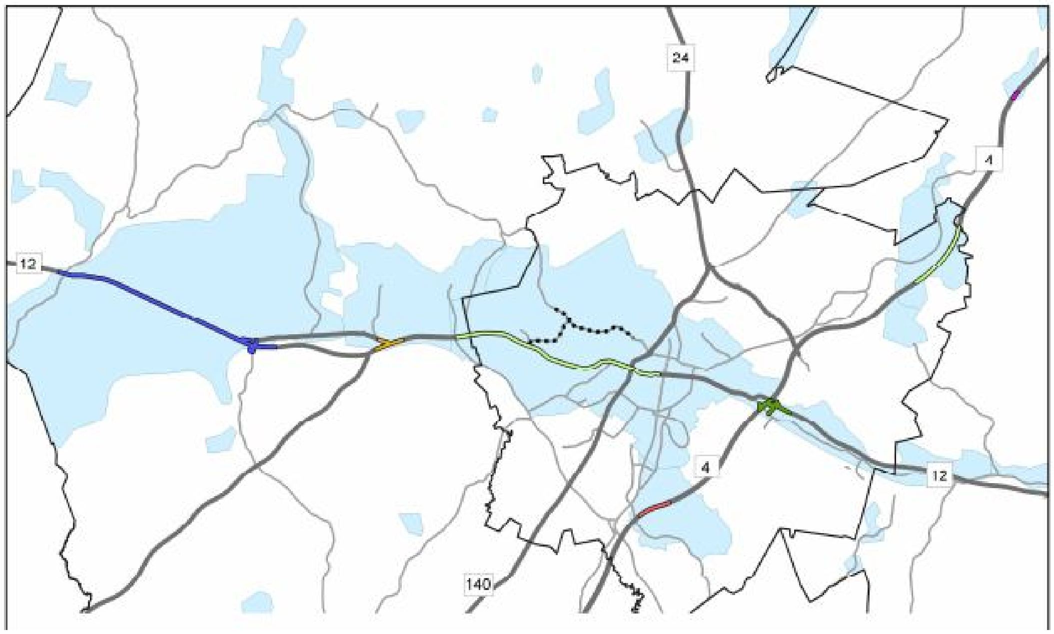


FIGURE 5. Groundwater protection plan area as well as transport of dangerous goods restrictions (adapted from Lahti Region Environmental Services)

4.5. Buy water from sellers

For interim, water can be bought from Lohja. This area was also selected due to the following:

Lohja water is tapped from the western edge of the extensive salpausselkä ridge system, considered to be left by the ice age in southern Finland.

Supply capacity is 514 m^3 / day (514.000 liters) 3600 m^3 / week (3.600.000 liters) or 14.400 m^3 / month (14.400.000 liters).

Lohja is advantageously located near the Helsinki metropolitan area and it benefits from a good road network. It takes only about a half an hour to drive to Helsinki for a major sea harbor connection.

It takes only about one hour drive to Turku for a major sea harbor connection.

4.6. Container for transporting

The thesis found out two suitable containers that can be used for transporting water in bulk. Flexitank/Flexi bag and Multi Fluid bag are strong, safe and economical to transport bulk water on a long distance. They have been try and tested by Flexitank Limited and Fluid-Bag Limited respectively.

4.6.1. Flexitank/Flexi bag

This PE plastic can transport 24.000 liters of water in one container (which is the maximum load of the 20ft container). The empty PE / PP (Polyethylene / Polypropylene) plastic sack is put into 20ft container. Then the sack is filled with water. See the picture below.

FIGURE 6. Flexitank and its accessories. (adapted from Alibaba.com)

The Flexitank has the following qualities (Alibaba.com):

- Manufacturing rate is 4.000 sets / month
- It has 4 layers of PE (polyethylene) plastic, plus 1 layer of PP (polypropylene) plastic.
- It has an integrated 3 inch valve
- Standard references: ISO 22000: 2005/ISO 9001: 2008
- Plastic colour is semi – transparent. It is possible to see through the plastic layers.
- Density of the plastic bag material is about 0.92g/cm^3 (gram/cubic centimeter), which is slightly lighter than water.
- Tensile strength (ASTM D 638 IV) 32Mpa (Mega Pascal)
- Elongation at break (ASTM D 638 IV) 800%
- Stress cracking ability (ASTM D 1693 B) □ 1500hrs
- Pulling force (ASTM D 1004) 133N
- Dielectric force (ASTM D 4833) 400N
- Oxygen permeability (ASTM D 3985) 120cc 02m^2 of material
- Loading error +/- 500L (Against rated capacity)
- Minimum loading temperature -30^{o}C
- Maximum loading temperature +70^{o}C

PICTURE 5. A set of Flexitank. It weighs 105 kg, and is 0.6 m^3 of volume (adapted from Alibaba.com)

4.6.2. Multi Fluid bag

Multi fluid bag can contain 1000 liters of water and 20ft container can take 20 Multi fluid bags. Multi fluid bag can be fork lifted from all four sides and from two sides with hand tracks. Multi fluid bag is also suitable for conveyor use, the inner containers are delivered in bags of 20 (15) and transport bags in boxes of 125 (250). Transport pullets in stacks of 7 – 10 refer the photo shown below. Multi fluid bag has the following qualities (Fluid-Bag Ltd):

- Maximum liquid density of 2.2kg/dm^3 (Water density is 1.0 kg/dm^3)
- Maximum vapour pressure at 55^{o}C 30.0kpa
- Maximum stacking height 3 containers (filled)
- Filling temperature -18^o - +70^{o}C
- Product residues as low as 0.3 – 1.0 liters/1000 liters

PICTURE 6. Multi fluid bag: the inner containers and transport bags in carton boxes, and transport pallets piled on each others (adapted from Fluid-Bag Ltd)

FIGURE 7. Multi fluid bag, the assembly of its parts: inner container, transport bag and pallet of steel (adapted from Fluid-Bag Ltd)

- Weight total about 90 kg, consisting of:
- Inner containers 4-6 kg
- Transport bag and poles 17 kg
- Transport pallet 60 – 72 kg

Dimensions (mm) (refer the Figure 8 below)

- Length: L = 1150 mm
- Width: W1 = 800 mm
- Width: W2 = 1170 mm
- Height: H = 1220/1325 mm
- Diameter ø = 1170 mm

FIGURE 8. Multi fluid bag the form and dimensions as filled (adapted from Fluid-Bag Ltd)

4.7. Transportation mode

Thesis suggests that, supposing flexitank is used for transporting the water, it will prefer to take road and sea for the transport mode.

The track will first transport 20ft containers to the collecting point and they will be filled while the container is still on the track. Refer the photo below. The track will then transport the water-filled container to a major harbour for sea mode transportation.

PICTURE 7. A flexitank is been filled with water on tracks (adapted from Alibaba.com)

However, in the case of multi fluid bags, rail transportation mode may be added. These multi fluid bags can be filled and fork-lifted into a truck, to send them straight to the port/harbour or to a train station to be transported by a train to the port, for sea transportation mode. Refer to the Figure 9 below, showing how the three transportation mode is used.

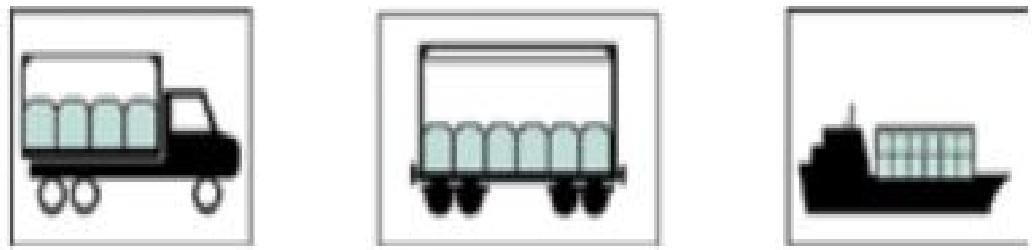


FIGURE 9. Multi fluid bag filled with water is been transported by 1) truck, 2) train and 3) ship respectively (adapted from Fluid-Bag Ltd)

4.7.1. Incoterm 2000

The thesis also suggested that FCA (Free Carrier) incoterm should be used in the case where the water is going to be bought. This FCA is where the seller fulfils his obligation to deliver when he has handed over the goods, cleared for export, into the charge of the carrier named by the buyer at named place or point. When, according to commercial practice, the seller's assistance is required in making the contract with the carrier (such as in rail or road), the seller may act at the buyer's risk and expense (Giant logistics Ltd)

4.7.2. The posibility of transporting Finnish water to Somalia

The thesis recorded five sea ports in Somalia as shown in the Table 6 below. Mogadishu, Berbera, Kismayo are deepwater ports. Somalia is at the entrance to the Gulf of Aden, which leads to the Red Sea and the suez canal, one of the world's most important shipping channels.

TABLE 6. Ports of Somalia (World Shipping Register)

PORT	LATITUDE	LONGITUDE	REMARK	UNCTAD	TIME ZONE
Berbera	10° 26.0' N	045° 01.0' E	Port Open	SOBBO	GMT +3
Chisimaio	00° 23.0' S	042° 33.0' E	Alt Name	SOKMU	GMT +3
Kismayu	00° 23.0' S	042° 33.0' E	Port Open	SOKMU	GMT +3
Merca	01° 43.0' N	044° 46.0' E	Port Open	SOMER	GMT +3
Mogadiscio	02° 01.0' N	045° 21.0' E	Port Closed	SOMGQ	GMT +3

The thesis found out that it is possible to export water from Finland, Helsinki port to Somalia, Berbera port. The sailing details are as follows:

- Port of loading Helsinki
- Port of discharge Berbera
- Distance 5591 nautical miles (10354.5320 Km)
- Vessel speed 14 knots
- Time 16 days 15 hours

FIGURE 10. Sea route map from Helsinki port to Berbera port (adapted from Sea-Rates.com)

It has been noted that Somalia have been one of the world's most dangerous stretches of water because of piracy. This is due to the absence of functional government for nearly two decades. However, Berbera port which have been chosen as discharging port, is at the entrance to the Gulf of Aden (the first port in Somalia as entered from the Red Sea) and it does not fall within the piracy zone, refer Figure 11 below.

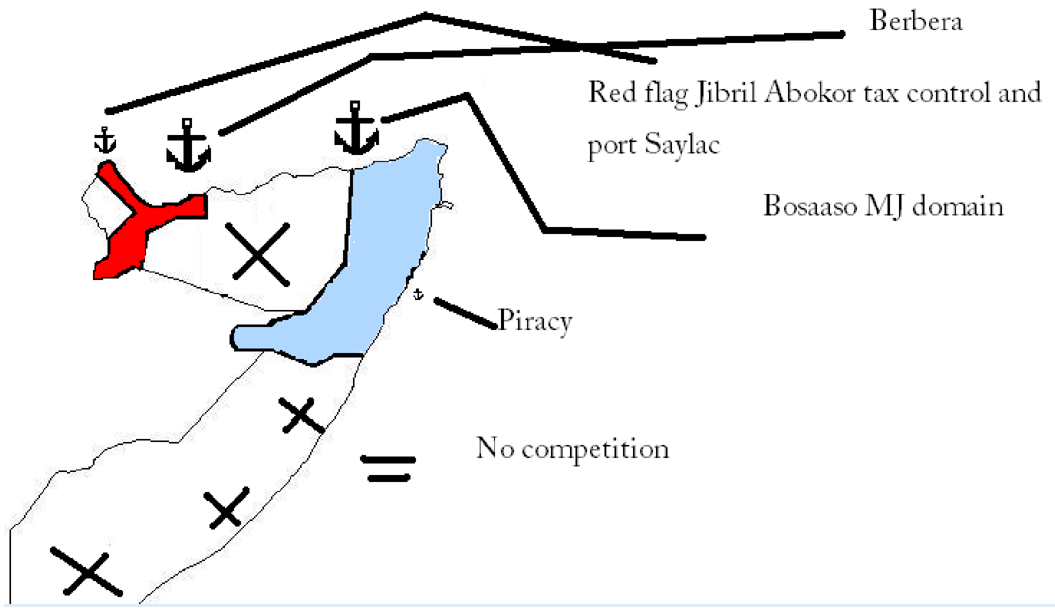


FIGURE 11. Map of Somalia ports and piracy zone (adapted from BenderBay, 2008)

Moreover, it has been suggeted at by the US Navel Institute on April 2009, how to thwart the Somali pirates at Sea. It was said that one posibility is in use in the Gulf of Aden, is to flood the Sea lanes with Sea policemen or naval forces who serve to deter or stops assaults on shipping in their beat area. They also detected periods when the pirates are likely to be active (low winds, day light hours, or during periods of bright moon) and ships that have proven to be at risk (low freeboard ship, slow transit speeds).

5. CONCLUSION

According to the objective of the thesis which is to help in finding the best possible way to transport Finnish water in large scale to areas that lack access to safe drinking water. It is disheartening to see the water situation is in abundance somewhere, while others are even dying because of lack of water. Now, according to this thesis, it is possible to transport 3.600.000 liters of water per week, or 14.400.000 liters of water per month from Finland from one single pumping area, at a reasonable cost based on flexibility, space-saving advantage, low product residue of container and the cost of quality water in Finland.

When the value of life lost, the amount of money spent on drugs for treating against water related disease are considered, it might not be too costly to transport excellent quality water from Finland instead. From the research carried out on Finnish water, it was found that Finnish groundwater is of high quality and it is also available in abundance. When the high quality of the water is put into consideration, Finnish water is relatively cheap. Also, the excellent Finnish infrastructure (roads, harbours, electricity, data connections, etc), and the stability and safety of the Finnish society increases the value of the idea of transporting water from Finland.

Therefore, all the organizations which fight for humanity, such as United Nations, World Vision, UNICEF, FIDA International, World Health Organization, Red Cross, and others, are allowed to, and should use this research work and its results, to help the world out from the scarcity of water. When this option is put into practice it will in the long run reduce water related diseases and death rate caused by it. To this point, would it be time to stop giving lectures on lack of access to water, and start raising funds for transporting water to areas that do not have it.
Water is life.

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APPENDIX 1

QUESTIONNAIRE

SUO MALAISEN POHJAVEDEN KANSAINVÄLINEN LOGISTIIKKA

Arvoisa suomalaisen pohjaveden asiantuntija,

Opiskelen tuotantotaloutta Pohjois-Pohjanmaan Ammattikorkeakoulussa, Ylivieskan koulutusyksikön, kansainvälisessä koulutusohjelmassa. Teen parhaillaan opinnäytetyötäni, jossa tutkitaan mm. Suomalaisen pohjaveden tarjontaa, sekä sen kansainvälisiä markkinoita ja logistiikkaa.

Työni tarkastelee kansainväliseen vientiin soveltuvan puhtaan pohjaveden tarjontaa eri puolilla Suomea, vedentuottajien vapaata toimituskapasiteettia ja hinnoittelua, sekä pohjaveden hyödyntämiseen liittyvää lainsäädäntää, ja veden laatuvaatimuksia. Opinnäytetyöllä pyritään paitsi kartoittamaan em. asioita, myöskin lisäämään suomalaisen huippupuhtaan pohjaveden, sekä sen toimittajien tunnettuutta maailmalla.

Lähestyn tällä kyselyllä sekä veden tuottajia että valvontaviranomaisia. Seuraavalla sivulla on lyhyt kyselylomake, jolla kerään pohjatietoa opinnäytetyöni tutkimuksia varten. Pyydän kohteliaimmin, että tutustuisitte lomakkeeseen, täyttäisitte tapaukseenne sopivat kohdat, ja palauttaisitte täytetyn kyselyn joko postitse tai sähköpostitse tammikuun 2012 loppuun mennessä.

Viranomaiset (kuten ELY –keskuksen henkilöstö):

- Pyydämme Teitä tutustumaan oheiseen kyselyyn, ja täyttämään sen soveltuvilta osin (esim. kohdat 1, 4, ja 6 soveltuvilta osin).
- Jos voitte joko toimittaa tämän kyselyn edelleen oman alueenne veden toimittajille, tai toimittaa meille alueenne vedentoimittajien yhteystietoja, olisimme kiitollisia.

- Otan mielelläni vastaan oman alueenne pohjavettä koskevia tietoja, kuten laboratoriotutkimustuloksia tai niiden yhteenvetoja, jos voitte toimittaa niitä.
- Tulen myös mielelläni lyhyesti haastattelemaan muutamien alueiden viranomaisia, koskien pohjaveteen liittyviä asioita kullakin alueella. Olisitteko kiinnostunut tuomaan omaa aluettanne esille tutkimuksissani?

Veden tuottajat:

- Oletteko kiinnostunut ajatuksesta myydä tulevaisuudessa pohjavettänne bulkkitavarana suuressa määrin sekä kotimaisille että ulkomaisille asiakkaille?
- Jos asia kiinnostaa teitä, voitte vastata seuraavalla sivulla olevaan lyhyeen kyselyyn, jossa yhteystietojanne, toimitusvalmiuttanne ja hinnoitteluanne kartoitetaan.
- Jos voitte liittää kyselyyn myös toimittamanne veden viimeaikaisia laboratoriotulosraportteja, otamme ne mielellämme vastaan vertailutiedoksi.
- Olen yhteydessä joihinkin vedentoimittajiin, haastatellakseni teitä opinnäytetyötäni varten. Olisitteko kiinnostunut esittelemään tuotantoanne haastattelussa?

Parhain terveisin:

Benjamin Boakye

Insinööriopiskelija

PPAMK, Ylivieskan kansainvälinen koulutusohjelma

Kyselyn voi palauttaa joko postitse yllä olevaan osoitteeseen, tai esimerkiksi skannattuna sähköpostilla osoitteeseen: benjamin.boakye@cou.fi

1. YHTEYSTIEDOT / CONTACT DATA:

Yhtiö/toimipaikka: Company/unit name:	
Yhteyshenkilö: Contact person:	
Postiosoite: Postal address:	
Sähköpostiosoite: e-mail address:	
www -osoite: www -address:	
Puhelin / FAX: Telephone / FAX:	tel: +358 FAX: +358

2.OMISTUS: OWNERSHIP:	Kunta / kaupunki: City / communal:			
	Osuuskunta: Society / coop:			
	Yksityinen yhtiö: Private company:			
3.TOIMITUSHALU: WILL FOR DELIVERY:	Emme ole halukkaita etsimään uusia asiakkaita: We are not interested in finding new clients:			
	Etsimme uusia asiakkaita Suomesta: We seek for new clients from Finland:			
	Etsimme uusia asiakkaita ulkomailta: We seek for new clients from abroad:			
	Toimitamme vettä jo nyt ulkomaisille asiakkaille: We already deliver water for foreign clients:			
4. KAPASITEETTI (alueenne tai yhtiönne): **CAPASITY (of Your regional area or of Your company):**	**per päivä**	**per kuukausi**	**per vuosi**	
Vesipumppaamo(ide)nne koko kapasiteetti: Total Capasity of Your Pumping Station(s)	m^3	m^3	m^3	
Vapaa kapasiteetti (kyky toimittaa uusille as.) Free Capacity (ability to deliver for new clients)	m^3	m^3	m^3	
5. HINNOITTELU: **PRICING:**	**10 m^3**	**100 m^3**	**1000m^3**	
Veden kuutiohinta erikokoisina toimituserinä: Water price per cubic in different volume deliveries	/m^3	/m^3	/m^3	
6. VEDEN LAATU / KAUSIVAIHTELU: **WATER QUALITY / SEASONAL QUALITY:**	**Talvi** **Winter**	**Kevät** **Spring**	**Kesä** **Summer**	**Syksy** **Autumn**
Erinomainen **Excellent**				
Hyvä **Good**				
Tyydyttävä **Satisfactory**				
Huono **Poor**				

LISÄHUOMAUTUKSIA / ADDITIONAL NOTES: