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SOLUTIONS TO WATER PROBLEMS IN THE BOTTOM OF THE PYRAMID MARKET

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ABSTRACT

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Solutions to water problems in the bottom of the pyramid market

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Solving the water crisis in the developing world is a critical issue. Four billion people in the globe, so called the Base of the Pyramid (BoP) population suffer from inadequate access to safe drinking water, while millions die daily from waterborne diseases and lack of clean water. The BoP people desperately need to obtain a satisfactory access to safe water sources.

In order to address the issue, this research has been carried out. To provide holistic consideration to the matter, comprehensive exploration of various causes of the water crisis and its impacts in developing countries were discussed. Then, various viable and relevant solutions to the problem have been thoroughly scrutinized, including scientific, rational, practical and speculative approaches, examination of existing methods, technologies and products at the BoP water market. The role of clean water to the sustainable development was specifically featured. The paper also has studied social and economic factors, actors and circumstances which affect the market development of clean water technologies in the BoP. Possibilities and potentials of successful business between foreign water enterprises and BoP consumers were considered, while primary obstacles are deliberated on, with suggestion of the ways to tackle them. Technologies and products which are needed by the poor must be affordable, sustainable and of an appropriate quality.

The crucial question of technology transfer was soundly discussed with pointing out main hindrances on the way of its implementation between the developed and developing world. The means to overcome these barriers were properly observed as well.

To explore to some extent the possibility and feasibility of technology transfer from Finland to the BoP sector, 3 case study analyses have been implemented. Personal discussions in form of interviews were conducted at Kemira, Outotec and Fenno Water, Finnish water treatment and supply enterprises. The results of the interviews shed light on the specific practical matters, actual obstacles and potential solutions of the technology transfer from Finland to low-income countries.

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Liubov Obraztcova

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LIST OF ABBREVIATIONS AND SYMBOLS

BoP – Base of the Pyramid

CSR – corporate social responsibility

DAC - Development Assistance Committee

EPA - Environmental Protection Agency

EU – European Union

FAO - Food and Agriculture Organization

GDP - gross domestic product

GLAAS - global annual assessment of sanitation and drinking-water

HWTS - household water treatment and safe storage

IAA - International Assistance Agencies

IDA – International Development Alliance

JMP – Joint Monitoring Programme for water supply and sanitation

MDBs - Multilateral Development Banks

MDGs – Millennium Development Goals

MNCs - multinational corporations

OECD - The Organization for Economic Co-operation and Development

OSAT - open source appropriate technology

POU – point of use

SDGs – Sustainable Development Goals

TT – technology transfer

WASH - Water, Sanitation and Hygiene

WBD - waterborne diseases

WHO – World Health Organization

WSS - Water supply and Sanitation

UN – United Nations

UNICEF - United Nations Children's Fund

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1 INTRODUCTION

'We used to think that energy and water would be the critical issues for the next century. Now we think water will be the critical issue.'

- Mostafa Tolba, former head of the U.N. Environment Program.

Dwelling in a one's own medium and living conditions which are quite satisfactory for being alive easily each of us should ponder over apparent economic and social disparities between different populations and socioeconomic strata. The harsh facts have to be contemplated: there is the huge, but poorest socioeconomic group of 4 billion people who lives on less than 2 dollars per day. Four billion people in the globe are called the Base of the Pyramid (BoP) characterized by unmet elementary needs such as access to clean water for drinking and sanitation, basic healthcare, education, financial services etc.

Well-known fact is that well over 50% of the deaths on the Earth are caused by waterborne diseases (WBD) and by the same reason 88% of the illnesses happen directly or indirectly in developing countries. "Each year, approximately four to five million children under the age of five years old die from WBD (about 300 per hour). It is estimated that 50% of the world's hospital beds are occupied by those suffering from WBD" (The Water Initiative 2006). Contaminating micro-organisms and particular pathogenic bacteria may easily appear in large numbers in surface water, meanwhile spreading mostly through drinking water – the most important human's need, which is dwindling with every minute. This and excessive minerals in ground water are the most urgent issues to solve mostly in developing and also developed countries.

United Nations' (UN)-water global annual assessment of sanitation and drinking-water (GLAAS) which is implemented by the World Health Organization (WHO) analyzes globally sanitation and potable water situation. It also formulates policies towards achieving the Millennium Development Goal (MDG) Target 7C (also referred as target 10 in some sources), which is to "halve, by 2015, the proportion of the population without sustainable access to safe drinking water and basic sanitation". The GLAAS report of year 2010 informs that by improving access to safe water and basic sanitation, considerable savings in health-care costs and gains in productive days can be achieved. Furthermore, economic costs of lost time in fetching water and the impact on the environment from wastewater pollution are high. It is also worth to mention that increasing people's access to sanitation and clean drinking-water greatly benefits the development of individual countries through improvements in health outcomes (GLAAS 2012). Although recently published, the MDGs Report 2015 announces that the global target for drinking water has been successfully reached, this progress seems to be unclear in relation to sustainability issues, i.e.

questionable quality and maintenance of improved sources of potable water for people. Vast load of work is to be done to guarantee that improved sources of water are and remain safe. And yet, the amount of population which is still deprived of basic sanitation and access to drinking water remains staggering, and those suffering are the most difficult to reach, the poorest and the most disadvantaged people across the world. Further actions must be implemented without a break.

Consequently, the General Assembly of the United Nations put out resolution for the adoption of the post-2015 development agenda as the outcome of multiple United Nations' conferences and summits in the economic, social and related fields. The document highlights the new Sustainable Development Goals which are presented in the 2030 Agenda for Sustainable Development. In particular, out of 17 goals the sixth one declares to ensure availability and sustainable management of water and sanitation for all, clarifying that every single person in the world has to gain an access to affordable and safe portable water as well as adequate sanitation by 2030. In particular, the document appeals to address with the special attention the needs of the poorest among least developed countries. (General Assembly 2015) Obviously, the whole BoP sector is referred.

The importance of either the MDGs achievement or the challenge of achieving Sustainable Development Goals (SDGs) cannot be overestimated especially in relation to the world water issues. The urgent necessity of providing potable water to indigent is manifest. Cheng et al. (2012) emphasizes that clean water and sanitation are not only integrated features of environmental sustainability, but their presence influences quite a few significant aspects of human life such as poverty and hunger, diseases, child mortality, maternal health, primary education and gender equality. Relevant research about an ecological quantification of the relationships between water, sanitation and infant, child, and maternal mortality had been also conducted by Cheng et al (2012). It caused remarkable public response while representing in details the analysis of the key strategies to ensure the contribution of meeting the MDG 7C towards alleviation of world's biggest issues. Besides, Sachs (2005) proposes the best strategies for meeting the MDGs, including improvement of sufficient access to domestic water supply and sanitation, which appears to be essential for meeting the health, education, gender, environmental, and other targets.

More than an estimated 2.2 million deaths of children per year could be prevented by the reduction of diarrheal and malnutrition related to unsafe water, inadequate sanitation or insufficient hygiene. (GLAAS 2010).

Such problems need solutions and ways to create opportunities for trustworthy drinking and sanitation water, especially in the middle and lower income urban and rural communities of developing countries.

Besides the above mentioned problems, following environmental matters have to be taken into consideration. The planet's ecosphere is a closed system where resources are limited. Thus, humanity ought to realize that ecosphere has inadequate ability to accumulate or assimilate contaminants which are generated by present-day's anthropogenic activities. Consequently, people cannot blindly exploit air, water, any other resources, otherwise reckless actions will end up with irreversible degradation, and even global catastrophe. 'Toxic substances such as organic chemicals (VOCs, PCBs, etc.), heavy metals, radioactive, and biological contaminants in water require the long-term and systematic policies that restrict more damaging production processes and induce safer alternatives'. Comprehending of these trans-boundary problems can be changed rapidly from the local to global solutions to environmental issues (Koltuniewicz and Drioli 2008).

Production of energy and water management are interrelated. Meanwhile, energy and water industries are the widest in the world. The energy industry needs huge amounts of water for producing and distribution of power whereas the water industry demands vast amount of energy to treat water by transporting, storing and managing with it. In addition there is growing amounts of wastewater from almost any kind of industries such as oil and gas ones, where again energy used to purify and refine dirtied water masses. Thus and so, while considering the global water scarcity crisis it is certainly seen that industries which use water treatment are becoming as much about water as it is about energy.

However, as an unforeseen and distressing fact for the majority of people, it has been lately revealed but still is not widely acknowledged that animal farming or industrial livestock production contributes to water pollution greater than all other industries together. For instance, the US Environmental Protection Agency states that animal agriculture is the number one cause of water pollution. To serve as an example, it claims that it takes 5% of all water used in the United States to satisfy domestic needs while 55% of the whole amount is contributed to the factory farming. Another truth, most likely shocking for public, is that responsibility of factory farming accounts for 20-33% of all fresh water consumption in the world today. Furthermore, the most paradoxical thing is that there is no discussion of such issue by world governments. Neither online water protecting communities mention it on their websites nor do people themselves show any concern. (Jacobson 2006; Andersen and Kuhn 2014)

Hence, it is obvious that if the world draws attention to this indisputable connection between availability and cleanliness of fresh waters and the animal agriculture inflicting absolutely irrational losses to it, there would be far less necessity of solving the world water crisis in emergency pace.

At the same time due to global warming and consequent caused water crisis around the world there are next troubles observed. Rising sea levels which leads to salinity to seep into fresh ground water, and water shortages are brought by unusual weather conditions like hurricanes, droughts and tsunami floods. This pollutes living areas for a long time. To secure safe water various recycling technologies should be developed and applied. (Oguchi 2012) With these issues, existing and potential environmental impacts could be significantly reduced by the modern water cleaning technologies which already exist nowadays or are in invention stage and developing process. In relation to sustainable development clean technologies are the new approach to meeting the need for clean water and to environmental protection.

Today's engineers should pay much attention to implementation and installation of water clean technologies, technologies that can provide the quality of water required while scaling back energy costs.

Finland is one of the leaders in the world in the field of clean technologies, especially industrial sewage treating technologies. With the fast development of markets in the developing countries and the need to solve water problem, water technologies developed in Finland are seen as potentially viable solution. For example, Thu (2011) hinted that great possibilities for Viet Nam's sustainable development are given by considering incorporation of Finnish clean technology applications into the industries of Viet Nam. At the same time, such possibilities could be developed to other countries, i.e. the cooperation based on spreading of clean technologies takes place between prosperous countries like Finland and developing countries.

In particular, Finland can be called the country that holds leading positions among the world when it comes to clean water. It has ample water resources, which are one of the highest quality in the world. The existence of high-quality water reserves has caused consistent growth of water-intensive industrial production in Finland, and it has also caused a development in water technology (Finnfacts 2012).

Without comprehending the whole spectrum of causes which have led to the current emergency situation with the safe water in the developing countries and the reasons which day by day only push the crisis forward it is unlikely to give careful consideration to the matter. That is why a

reasonable part of the paper's theory is allotted to the thorough grasping of the problem's origins. Besides, the search for the plausible sustainable solutions to the water issues is preceded with the consideration of existing nowadays measures and actions executed to address the problems, together with their analysis and in some cases criticism of the methods which seem generally unsustainable or unsuitable for the implementation in the developing countries. Among the presently existing solutions to the availability of safe water in the BoP market a range of the most appropriate technologies and products is mapped and briefly talked about. The paper also strives to answer to the question how could a developing country avoid overexploitation of its natural resources and take the path of sustainable development, particularly referring to the sustainable water management which is crucially important in reaching such goal, while attaining equilibrium among social, economic and environmental requirements. Furthermore, it is shown that in order to provide adequate water supply sustainably, application of clean water technologies is imperative. Thus, it is as relevant as never to consider the clean water technology transfer to the developing nations, particularly from Finland, the global leader in the development of such technologies. However, the issue of technology transfer from developed to developing country is surrounded by number of obstacles which are presented in this research to some degree. In addition, a very distinctive concern of finding solutions to the water crisis among the poor is the challenging development of the water market at the BoP. This issue is thoroughly discussed as well in the paper.

Objectives

- comprehensive exploration of the various causes of the water crisis in developing countries and its impacts

- scrutiny of plausible solutions to the crisis, addressing the problem with the different approaches, including examination of existing methods, technologies and products

- consideration of feasible solutions, actors and factors which affect the market development of clean water technologies at the BoP

- fulfillment of the 3 study cases of chosen Finnish companies for the purpose of learning the potentials of technology transfer from Finland to the BoP sector

2 ACCESS TO CLEAN WATER: A CHALLENGE IN DEVELOPING COUNTRIES

Water, the most essential need in the world after air, embodies to be a reason of severe destiny in living conditions for more than billion people on Earth. While one barely hears about water scarcity on the planet, billions of others face it by day-to-day struggle to survive. Bare listing of statistics and increasing number of fiercely alarming facts within the problem, perhaps, cannot elucidate for prospering part of the world the actual circumstances of populations who has to refuse a possibility to realize their potential, to actually live their lives, because of daily water crisis, which turns them into permanent harsh survival.

Unlike ecological catastrophes as hurricanes, earthquakes or other natural disasters, the global water crisis does not appear in news headlines though everyone has heard about it. While this is a silent crisis undergone by those who are hard up for money, let alone water, developed part of the world has technologies, recourses and powerful governments to help it. So far being an impediment to human progress the crisis restrains world development, making over a billion lives confront constant obstacles in the way of dedicating safe water fetching and not living their lives as they have rights to.

According to the UN-water global annual assessment of sanitation and drinking-water (GLAAS) 2010 report, "in 2008, over 2.6 billion people were living without access to improved sanitation facilities, and nearly 900 million people were not receiving their drinking-water from improved water sources". As presumable results "two and a half billion cases of diarrhea occur in children under five years of age every year, and estimated 1.5 million children die from it annually" (WHO 2010).

The National Chairperson of The Council of Canadians, founder of the Blue Planet Project, Maude Barlow in her speech to the Water Rights Conference in Mexico City on March 2006 says that today, roughly one third of the world's population is affected by water scarcity, "every eight seconds, somewhere in the world, a child dies of water-borne disease". Thus, if ongoing course remains, two thirds of the populace of the planet will suffer from inadequate access to clean water by the year 2025." (Barlow 2006) Humanity fails to realize that polluting world surface water and depleting ground-water resources we exploit nature faster than it can be regenerated. Barlow (2007) detects almost complete deterioration of Africa's 677 major lakes which can become swamps in coming decades. Pollution has endangered 80% of South Africa's rivers. There is heavy water crisis in more than 22 countries of Africa. Similar exhaustion of resources troubles literally

every developing country on our planet. Nearly 75% of surface water in India, Vietnam and Pakistan are contaminated with poisonous or harmful substances while ground water resources had been almost exhausted. Therefore in order to maintain agriculture sector governments had to implement special water management techniques. Contamination of underground water in China's cities reaches 90%, and polluted water is what millions people drink there every day. Talking about Mexico severe pollution takes place in surface waters. Thus, 75% of population's water needs are being extracted from the ground (Barlow 2006). Practically, unwise passivity in undertaking actions towards the water crisis is mainly the fault of the world's most powerful economic and political elites, who fail to take into consideration that the world's disappearing freshwater resources are the collective heritage of humanity, and by no means a kind of 'Blue Gold' which is theirs to handle, but instead a precious resource which they must preserve. Yet, there are corporations of so called 'water hunters' which assume the right to the planet's water sources, and make enormous profits on them, while damaging the lives of entire communities who live in the territories bordering the built at will enterprises. "Last year, bottling companies put close to 170 billion liters of fresh water into plastic bottles, creating a massive new source of pollution. If only half of the USD 100 billion that the world's wealthy spent on bottled water in 2005 had been spent on infrastructure and treatment, every human being in the world would have clean drinking water today." – Such astounding facts were revealed by Barlow (2007). Besides, one can barely imagine how producing all those plastic bottles is influencing on the global issue created by enormous amount of plastic waste in the oceans.

Highly unjust actions are being undertaken towards local governments: transnational water corporations appropriate controlling and management of water supplies to sell it for those who are willing to pay and offering no opportunity to reach resources for those who do not have money. Some of those companies are the biggest and wealthiest on the planet, still they do not feel any obstruction to buy whole river systems, taking control upon it and assign rights for themselves in refusing essential source of life for millions inhabitants (Barlow 2006).

So far, we are facing the global water crisis trying to inquire into various complications of it; and though one might blame implementation of wrong policies, national and international mistakes in decision-making on the allocation of sources or weakness in educational programs for water-related professions, - there will be no result by searching for guilty party, while this menacing situation continues already for such long period of time. Whilst lives of billions are affected, humanity have to act right away without procrastinating.

There are plenty of incontrovertible evidences which proved by competent parties that water will give large financial returns into countries' economics, let alone inestimable contribution to national health if government invests in basic sanitation and drinking water for inhabitants.

Development of impoverished nations will be raised because of improvement in health outcomes. Recent researches showed that number of children who die every year because of waterborne diseases will be reduced considerably. According to investing in sanitation and drinking water, the World Bank estimated serious economic returns to average approximately 2% of gross domestic product (GDP), rising to over 7% in some specific country contexts (WHO 2010).

Despite number of existing water problems in particular mentioned above there are solutions being undertaken by domestic and foreign organizations. However often resolutions are not obviously well aimed, and those in most need are out of target. Serious responsibility, improvement in policies and good progress on aid decisions made are necessary for needy communities which unable to help themselves (WHO 2010).

During next few decades water difficulties will inevitably grow. Due to constant extension of population of the planet and corresponding rising incomes, water is going to be more and more used commodity. Unfortunately, its overuse is almost unpredictable, however it is distinctly forecasted that water consumption will inevitably increase. With the intensified water use the waste water issues go hand in hand, radically lowering living conditions of affected. The urban community living in developing countries is projected to widen drastically, engendering demand well over and above the capacity of already inadequate water supply as well as sanitation services and infrastructure. It's foreseen that by 2050, at least one in four people has a misfortune to dwell in a country affected by chronic or recurring deficit of freshwater (UN/WWAP 2003).

2.1 Questions on the inadequate or lack of access to clean water in developing countries

2.1.1 What causes this water problem?

Population growth in concert with internal migration and change of human behavior are, beyond dispute, some of the most plausible grounds for creating quantitative and qualitative water problems. In developing countries chaotic and disorganized growth in metropolitan or other urban areas is caused by people movement from the countryside mainly the rural areas into the cities in search for better life (Fischer 2009). In the developing countries the increment of population is forecasted to account for 90% of the total estimated growth (Alrusheidat 2004). What is in some aspects seen as economic development, the migration of people from rural to urban areas appears

to be an impediment when talking about providing of water services in the consolidating communities. Omitting the economical purposes of rural dwellers to move out from villages and their uneasy struggles to settle, it can be clearly stated that majority encounter even greater issues by water sector of urban areas. Increasing amount of urban dwellers may impose water and sanitation infrastructure complications, especially when talking about developing countries where construction of the basic facilities are usually poorly planned and chaotic. Population growth inflicts considerable challenges in formation of a new infrastructure in cities of many developing countries. However, the problem of substantially bigger scale occurs when uncontrolled demographic increase and rural-urban migration cause intensified water demand (Gleick 2004; Shiklomanov and Rodda 2003; Hinrichsen et al. 1998; Rosegrant et al. 2002).

Expansion of population translates into an increase in food production and enhancement in industrial activities, which addresses to cumulative water need. Urbanization generally occurs in a chaotic and vague way, without a plan. Such pattern challenges urban water supply systems, often tremendously. (Bruggen 2010) Furthermore, as time goes by, infrastructure of water services is aging. Getting older water networks and acceleration in population growth which cause rapid increase in water demand and corresponding demand for network expansion, generate abnormal pressure on infrastructure (Hammond et al. 2007). Eventually, in such circumstances the water demand cannot be sustained.

Changing lifestyle also leads to the increase in the amount of water used per capita in a community. If the existing infrastructure or available resources cannot address growing demand, water scarcity appears. Furthermore, greater use of water results in heavier amounts of wastewater released into environment. Often these flows of discharge are full of pollutants, and to reuse this water more and more sophisticated purifying techniques are needed. (Gündüz 2015) Besides, excessive use of wastewater systems, landfills, sewers and septic tanks in metropolitan areas leads to deterioration of water quality, notices Cutolo (2013).

As for water issues brought by agriculture, it is known that irrigation streams deliver contamination to surface and groundwater bodies through the use of fertilizers and pesticides, claims Iglesias (2007). Agricultural toxic substances penetrate aquatic and terrestrial habitats and groundwater mainly through leaching or volatilization of the waste streams. Irrigation-return flows impact natural systems and drinking water. (Tilman 2002)

Comprehensive meta-analysis of nearly thousands of studies relating pesticides and insecticides in global use was conducted by Stehle and Schulz (2015). The research has revealed that in few

thousands of reviewed cases, use of agricultural chemicals with a high probability causes the loss of biodiversity in "agriculturally impacted aquatic ecosystems" along with the habitat degradation. Considering how the developing countries are used by global corporations primarily for agricultural purposes, and the fact that croplands dominate large areas in these regions, it is not difficult to imagine how heavy use of highly biologically active substances threatens and literally influences the water systems and therefore health of indigenous people.

In addition to high rate of population growth, Bruggen (2010) identifies another two factors of water supply problems particularly in urbanized regions in developing countries, which are deficit of investments in water supply infrastructure and the upper limit imposed by the availability of water sources. Bruggen blames political and military instability and poverty as the context of these interrelated reasons of water issues. What's more, even when some investments become available, corruption and misuse of water resources cause poor planning and implementation of water supply projects. In addition to making resources "disappear", corruption has another adverse side effect: it scares away potential future investors who get frightened for projects feasibility. Scaring off investments from water sector, evidentially, is a measureless loss for public, taking into account that the economic cost of providing the necessary infrastructure is usually high. Aforementioned factors also lead to inadequate maintenance of existing urban infrastructure and accumulation of uncompleted projects. Speaking of efficiency of available scanty water supply networks in undeveloped countries, it reaches only 40-60%, which shows that about half of distributed water gets lost on the way. It is not surprising that local community is not willing to pay for such irregular provision of uncertain quality water (Khatri and Vairavamoorthy 2007).

Climate change and global warming threaten fresh water security in the world, particularly in the developing countries. The global hydrological cycle, which is already badly influenced by anthropogenic activities, escalates its intensity due to the temperature increase, which is followed by a raise in the amount of energy in the earth's atmosphere. Subsequently, water availability is affected by the change in runoff and tropospheric water content, as well as rainfall patterns and evapotranspiration. (National Research Council 2011) Nowadays it is widely accepted that changing climate patterns are the culprits of the temperature surge and mostly declining precipitation conditions around the world. Also, instability of precipitation conditions has become associated with growing probability of extreme events, such as floods, droughts, heat waves and "pressure that is exerted on fresh water resources." (Gündüz 2015) Furthermore, increased spatial and temporal variability of precipitation concentration during the year is responsible for decreased percolation abilities to restore groundwater reserves, higher rate of erosion and sediment deposition to storage structures (Gündüz 2015). The security of groundwater resources will be

especially altered, because their long-term renewal is controlled by long-term climate conditions (Yoxas 2012). Alteration of precipitation patterns and its intensity, caused by changing climatic conditions, may increase water scarcity, especially in the subtropics and mid-latitudes, where many of the low-income populations live (Meehl et. al. 2007). For instance, executive summary of the IPCC Fifth Assessment Report claims with high confidence that "climate change will amplify existing stress on water availability in Africa", and that consequences of the climate change will bolster not only insufficient access to safe water, but also complications of sanitation improvement, food security and access to health care and education (Abdrabo et al. 2014). Admittedly, climate change creates impediments to water availability, however deterioration in water quality usually follows. (Gündüz 2015)

Nowadays a great number of developing countries heavily rely on ground water natural resource. However, with the current scale of demand which is only accelerating, the ground sources will soon cease to flow or will be damaged in the majority of the regions. Apparent image of water abundance under the ground due to pervasive supply has brought association to the resource's permanent availability. As opposed to this stereotype, the real situation may arise very negative repercussions due to ground water overuse. Excessive ground reserves withdrawal can cause either shortage of the resource or its complete depletion, meanwhile imposing negative impacts on ecology and hydrology, as well as climatology and geomorphology of basin area and surrounding bio and eco-sphere. (Ponce 2006)

Management of water security and its either temporary or long-term unfavorable consequences in developing countries usually depends heavily on water governance, what is agreed by majority of academic researchers and practitioners (Araral 2013). The Global Water Partnership (2002) described water governance as "the range of political, social, economic and administrative systems that are in place to develop and manage water resources, and the delivery of water services, at different levels of society." For example, the World Water Vision Report blames poor governance and poor incentives, bad institutions and bad allocation of resources, claiming that these are the prime reasons of water problems (Cosgrove and Rijsberman 2000). Specific issues in water governance appear due to poor identification of mechanisms for developing and managing water resources, hence, operational implications for research and water policy are unclear (Araral 2013). Similarly, UN (2004) reckons poor governance in respect to water management as one of the major obstacles to draw proper investments in the water sector. The hindrance consist in the idea that high political risks, instability of regulative practices and unprofessional conduct of authorities

result in governance's inability for appointing investments straightly to the sustainable water projects, and also source attracted financing where it is intended.

Problems in water sector seldom become one of a political priority. Künzl and Barkemeyer (2013) say that at the national level it is the lack of efficient integrated and sustainable water resources management, at the international level there is often no effective instrument for cooperation to use sustainably water resources across borders. It comes as no surprise that the biggest challenges of water governance exist in undeveloped world, wherein this situation brings harsh reality for native people.

Due to uneven freshwater resources distribution across the world, over 2.3 billion people in 21 countries are located in water-stressed areas. Statistics show, that a person living in these areas barely obtains from 1000 to 1700 m^3 of fresh water during a year. Moreover, "some 1.7 billion people live in basins under scarcity conditions (with less than 1000 m^3 per person per year)". (Steinfeld et al. 2006)

The shortage of water together with the water policies set up by governments affect the water capital management of a country. UN MDG report (2015) represents that the shortage "can be physical (lack of water of sufficient quality), economic (lack of adequate infrastructure, due to financial, technical or other constraints) or institutional (lack of institutions for a reliable, secure and equitable supply of water)" (UN 2015, p. 55). Figure 1 illustrates area of physical and economic water shortage in the world.

As we see from the Figure 1, the situation with water scarcity predominately in the arid and semi-arid areas, where majority of least-developed countries are situated, is close to critical. In the developing countries all of the 3 aspects (economic, physical and institutional reasons) compromise health and lives of its inhabitants. At that, the biggest culprit of the water use and pollution appears to be agricultural sector which withdraws and alters 69% of the resource primarily by irrigation, whilst industries account for 19% and municipalities take up just 12% of total freshwater reserves.

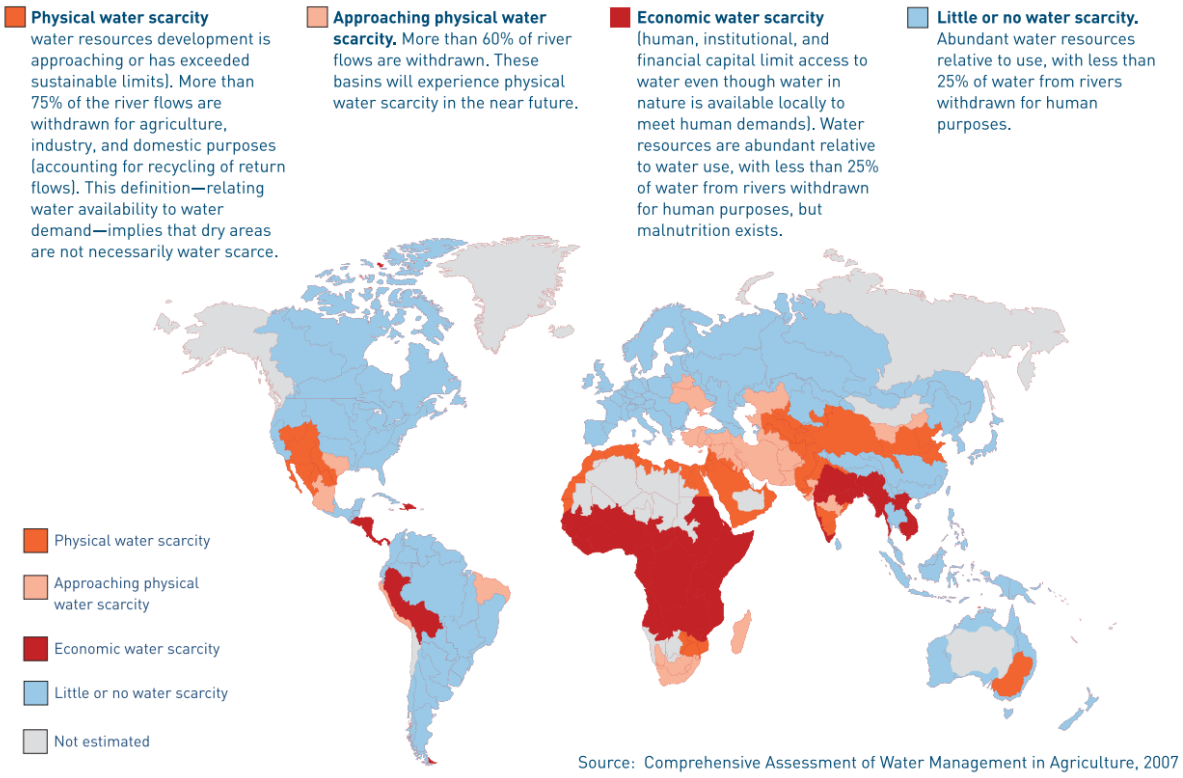


Figure 1: Areas of physical and economic water scarcity (FAO Water Informational Posters, n.d.)

For the more comprehensive analysis of the water pollution inflicted by human's activities and behavior, we must take a critical look on causes and consequences in perspective.

Most of the existing in developing countries large industrial plants are owned by the multinational corporations (MNCs), which are being furiously craved for by the governments in the expectation of the great benefits which could be brought by them into national economy. However, it is common that rights of the indigenous populations appear to be violated by the activities of these corporations, especially in respect to the water as fundamental human need. (Giuliani and Macchi 2013) Moreover, in this case advancement in the economic sector is highly prioritized over environmental sustainability. While natural resources are being excessively exploited to create revenues and execute foreign exchange, following environmental degradation aggravates living conditions of millions and what is critical, deprives populations of safe water. For instance, exploitation of oil reserves in the Niger Delta region of Nigeria and related actions of MNC entrepreneurs has led to massive water pollution among other impacts (Omoju 2014). Another example is shown by the dispute between Indian community and Hindustan Coca-Cola Beverages company. Intensive ground water extraction for the company's use caused critical water shortage in the area and heavily endangered quality of the resource (Chowdhury et al. 2011).

Nevertheless, dominance of current economic growth in the developing nations makes authorities to shut their eyes to the acute danger placed upon environment, especially, precious water resource. Clearly, many giant corporations operating in the developing nations, are attracted by the eminently diminished environmental legislations and poor institutions of developing nations to protect natural resources in comparison with the developed world's strict pollution laws and taxes. Hence, as bad luck would have it for powerless, multiple enterprises which transfer production lines to the developing nations, deviate easily from environmental responsibility, thereby gaining conflicts with the local populations by threatening their access to clean water, in particular.

Generally, absence of strict environmental legislations and water protective policies causes neglecting of sustainability issues by industries in developing countries. As a result, untreated effluents being dumped from the factories strait to the local waters, often severely polluting them.

Apart from the anthropogenic activities such as man-made heavy industries and production of materials, goods and services, which arouse multiple water problems in developing countries, there is another human's factor peculiarly influencing on the natural resources, specifically on water one.

As was mentioned a while ago, cumulative effects of habits of continually growing population have a potentially tremendous impact on climate and water pollution. As the population count continues to rise, developing countries are the driving force behind this. In addition to the existing industries and other contributors of pollution, daily activities of over 7 billion people quickly add up to an impressive amount of strain on the environment. Today reducing our carbon footprint is a common concept that most can understand, but the equally important need for reducing our water footprint is commonly overlooked. This could be due to the fact that most water problems affect the poorest countries the worst, which do not have as large capacity to deal with the problems as developed countries do. (Alrusheidat 2004)

Nowadays, given all kinds of causes of water issues, dietary choices and corresponding water footprints begin to play one of the major roles in situation with progressive water pollution. And perhaps, the largest sector of unused potential to provide the serious reduction on global water footprint is the animal agriculture. Impressively, Gerbens-Leenes, Mekonnen and Hoekstra (2013) write that use of animal products is responsible for nearly third of the whole water footprint of the entire human race, while in a global scale, agricultural activity accounts for 92% of the fresh water footprint laid by world population on the water resource. In the USA in 1995 the water used for irrigation of feed crops was a staggering 56% from the total annual water consumption (Jacobson 2006; Hoekstra and Chapagain 2008).

‘A global assessment of the water footprint of farm animal products’ reveals that animal products contribute to a much bigger water footprint in comparison with the plant products. This is largely due to the water consumed and the feed grown to raise the livestock for slaughter or dairy use. Choosing a crop wisely, which directly fits for human consumption, can save tremendous amount of water and also deforested land to produce the same nutritional value. Raising livestock for food wastes the water used and the nutrition provided by the plants to merely feed the animals, as there is no need to feed the mediator. Those crops could directly feed the human population. (Hoekstra 2012; Gerbens-Leenes, Mekonnen and Hoekstra 2013; Jacobson 2006)

What is even more problematic to cope with besides water quantity is its quality issues. The effects of livestock on water quality are extremely underestimated and are failed to be taken into account by humanity. For example, water pollution from industrial agriculture is one of the leading causes of water pollution in the United States, as it has the largest consumption of animal products per capita in the world. In the year 2000 a study was conducted by Environmental Protection Agency (EPA) called “National Water Quality Inventory”. In this study 48% the water quality problems in rivers and streams of the United States was deemed to be contributed to agriculture. Furthermore, agriculture is also responsible for pollutants that worsen the aquatic life or interfere with public use in 41% of the assessed acres in impaired lakes. (EPA 2000) The experience of highly developed USA should demonstrate convincing example of where ‘developing’ with the wrong habit choices can lead to in respect to water resource preservation.

Water pollution from industrial farms is mainly a result of animal waste, which is needed to be disposed of, or stored. The production of manure and urine is often much larger than the capability of using it as fertilizer. Especially the large factory farms of today have big “lagoons” to store manure and other waste from the farm. These lagoons can leak, rupture or overflow, which results in environmental damage by the bacteria that can find its way into the water supplies and ground water. Most common forms of water pollution are nitrogen and phosphorous in high levels. Both of these are largely the result of fertilizer runoff. Using the waste as fertilizer could also introduce more toxic substances to the water from livestock excretions, such as pharmaceuticals, which are largely used to treat the animals in factory farms to withstand the bad conditions. (Grace 2015)

In Shandong province China, a study was carried out to find out about the effects of increased livestock and poultry breeding on the water environment. The study was concentrating mainly on excretion quantities and the nitrogen and phosphorus pollutant levels in the water. Comparative analysis was used to compare breeding, agriculture and rural life point sources. Huo et al. (2009)

has found that the quantity of big livestock has a considerable impact on the output of excretive nitrogen and phosphorous pollutants of livestock and poultry. Comparing the pollution impact index of 1989 against 2005 revealed a 17% increase, this was mainly because of the increase in the number of livestock and poultry. Furthermore they found out that after 2003 the pollutants downward trend as a result of decrease in the big livestock. In 2003 the annual growth rates of variety of pollutants, like COD, NH3-N, TN and TP, had been between 5.72% and 6.13% respectively. According to Huo et al. (2009) the pollution of livestock and poultry is gradually becoming a main source of water body pollution.

Increasing standards of living is part of the development of countries. Poor nations have commonly more emphasis in plants as a staple in their diet, which is mainly due to the lower cost in production and higher yield in calories of food for the people. Farming for meat and other animal products are luxuries that become more accessible with economic development. This means that as the populous of a country gets wealthier, the consumption of animal products is increased with the living standards because they can be afforded. Simultaneously, the typically populous parts of a poor nation will overstress the natural resources with the demand of animal products that become accessible with wealth. This is due to the higher water footprint and pollution that are part of using animals as food and commodities. Therefore the growth impedes itself to a certain extent, unless the culture favors animal-free and plant-based lifestyles. China has been a great example of this in the past decades, as its beef, pork and poultry consumption has been steadily increasing and is estimated to continue growing in the future as well. (Gerbens-Leenes et al. 2010)

One of the early researchers to indicate the size of the issue of growing food demand was Sadik, who in 1991 described that over that decade a billion more people would inhabit the earth. This increases the global demand on food and water, which will in turn "increase the pressure on natural environment already suffering serious problems, destroying livelihoods and reducing biodiversity" as Alrusheidat (2004) wrote. As a countermeasure, the focus must be put on acquiring sufficient food products for all of humanity. If nothing is done the population growth and climate change will in combination result in record famines. (Alrusheidat 2004, Pun & Maass 1998)

2.1.2 How water problem impacts the lives of the poor people?

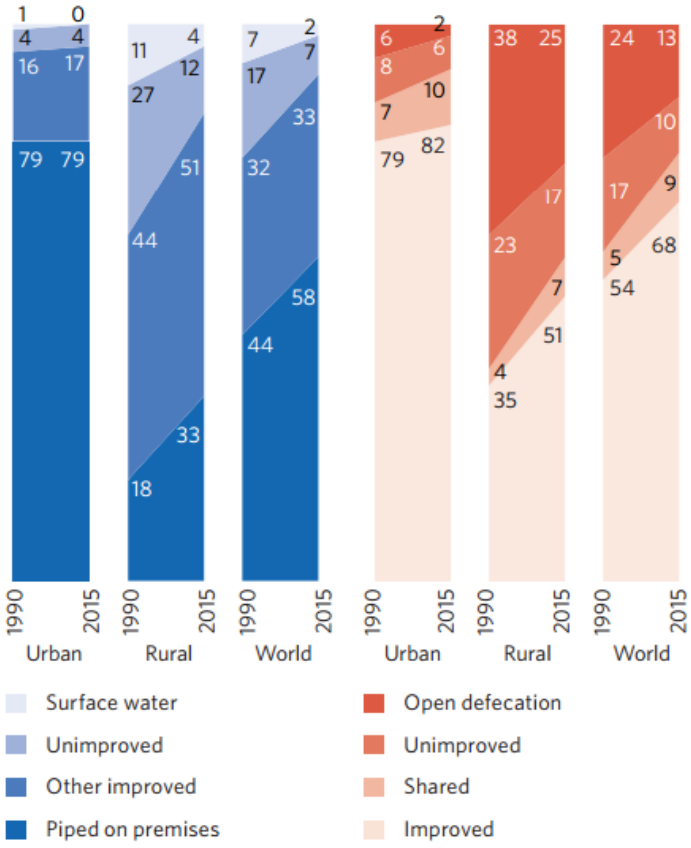
Despite positive accomplishments in achieving the MDG target number 10, newest data on water situation analyzed by United Nation organization announced in the MDG report 2015, shows that

663 million individuals still remain with unimproved or unsafe drinking water sources. Inhabitants of left behind communities have to resort to unprotected distant wells and polluted surface waters. Practically, half of all these people are dwellers of sub-Saharan Africa, about one-fifth is from South Asia, and what is the most unfortunate thing, lion's share of all live in developing countries. Besides, presenting a water source as 'improved', MDG target 10 characterizes only the quality of water at its source but not the safety of it as it reaches the consumer. Thus, the claimed success of reaching the goal might be ambiguous because water easily contaminates during delivery from the source to the user or at the storage (Vousvouras and Heierli 2010). In addition, the report clearly states that the part of the 7C goal on basic sanitation had not come to success, and "in 2015, 2.4 billion people are still using unimproved or unsafe sanitation facilities, including 946 million people who are still practicing open defecation." Moreover, deterioration of the environment and climate change sabotage any positive progress without a break. Nearly 40% of world's population is affected by water scarcity, and the situation is estimated only to worsen. (UN 2015)

Four million deaths per year is accounted for untreated sewerage pollution of shores globally, while contaminated water used for bathing purposes frequently causes gastroenteritis and claims nearly 250 million lives a year. Infectious hepatitis in its turn takes up to 100 thousands lives every year. (UN 2004)

Table 1 illustrates the 1990-2015 projection of the proportion of amount of people who use either improved or unimproved drinking water sources and sanitation facilities in urban and rural areas as well as across the world.

Table 1: Proportion of population using improved and unimproved drinking water sources and sanitation facilities, urban, rural and world, 1990 and 2015 projection (percentage) (UN 2015)



These staggering numbers may introduce one into a harsh living conditions of billions which could seem barbaric for the prosperous part of the world, however the reality is actually even worse than one can imagine, and those deprived of clean water and sanitation are literally struggling in the day-by-day survival circumstances.

Poverty, inequality, discriminations on multiple grounds and unequal power relationships are both, origins of the water and sanitation problems and its burdensome consequences (Van de Lande 2015; UNDP 2006). Likewise, problems in water quality and quantity can, on the one hand, cause serious troubles in sanitation practices, and from the other hand, poor sanitation has a severe effect on water quality and therefore, human health. Thus, the United Nations High Commissioner for Human Rights (2010) admits that "the absence of adequate sanitation systems in many parts of the world has led to widespread pollution of water sources that communities rely upon for survival", furthermore, UNICEF and WHO (2008) claim that lack of adequate sanitation contaminates water courses worldwide and is one of the most significant forms of water pollution.

Speaking of reaching the MDGs in regard to water and sanitation targets, there are two key quality issues which threaten the accomplishment of such goals. First, caused by insanitariness, and one of the prime menaces to the water quality is the microbiological contamination of drinking water by fecal, which brings about 4000 fatal cases a day from diarrhea among the young under the age

five. In turn, what is common in developing countries, when not properly treated, diarrhea leads to deaths, accounting for four billions cases per year. Moreover, repeated incidents of the disease seriously stresses person's immune system, making him more vulnerable to malnutrition and other illnesses. Second, there is a great hidden danger, which consist in the form of naturally-occurring arsenic and fluoride in the drinking water. These two elements are threats to the human health, especially in the long run, if water is not purified properly from them. For example, prolonged exposure to small amounts of arsenic in drinking water causes painful skin keratosis (hardened lesions) and can result in cancers of the skin, lungs, bladder and kidney. Similarly, the effects of fluorosis appear, generally, after the long-term exposure to contaminated, usually ground water. Fluorosis has become endemic in more than 25 countries in the world, mostly in developing regions. (UNICEF 2003, 2012)

Water pollution contributes to the spread of serious human diseases. The problem is critical in majority of developing nations, which discharge an estimated 95% of their public and about 70% of industrial untreated wastewater strait into surface waters. Downstream, harmful water is used for human needs such as drinking, cooking, washing and bathing. The consequences are tremendously negative, a lot of community members get ill and infected. It is calculated that nearly 90% of all human infections in developing countries are waterborne. Among the most adverse diseases, which are closely associated with the water pollution, there are wide spread incidences of schistosomiasis, mosquito-borne malaria, tuberculosis and various types of helminthes infections (tapeworm, liver fluke, leech). (Bernstein 2002; Pimentel et al. 2004) To that listing as the most common water and sanitation-related diseases UNICEF (2003) adds diarrhea, arsenicosis, cholera, fluorosis, Guinea worm disease, etc.

One of the most dangerous consequences of water scarcity as well as of interconnected climate change, are droughts which limit and restrict agricultural activities, which in its turn, is a menace of hunger among people and animal. Damages, caused by droughts bring about likely more losses to crop yields than caused by any other issue. To realize how badly plant drought stress influence on the inhabitants of the disaster areas, one should recall that it was the reason of enormous famines in the history. The harshness of drought is hard to predict, it depends on different factors, such as "occurrence and distribution of rainfall, evaporative demands and moisture storing capacity of soils". (Farooq et al. 2009) Being one of the climate change consequences droughts have been destroying crops over decades, bringing hunger and disruption, while at the same time provoking acute conflicts among affected populations. For instance, President Barack Obama has associated

droughts to the cases of violence and even terrorism, which have occurred due to instability in Nigeria. (Koch 2015)

The inability of developing world's population to access water of appropriate quality, increasing shortage of water reserves and inadequate sanitation adversely influence on society livelihood, income choices, chances to obtain decent education and opportunities to have proper jobs, it also impacts food security as one of the main means to survival. (UN/WWAP 2003) Plant agriculture endows population with the prime source of essential for survival nutrients, which cannot be obtained without appropriate water supply (Pimentel et al. 2004). The Food and Agriculture Organization (FAO) estimated 17% decline of food supplies per capita over the past 20 years, partly due to population growth, as well as concurrent shortages of fresh water. (FAO 2012) Many countries in a band from China through India and Pakistan, and the Middle East to North Africa either currently or will soon fail to have adequate water to maintain per capita food production from irrigated land, claims Tilman (2002)., severely decreases agricultural prospects especially at the coastal areas of lakes, rivers and reservoirs What's worse, deterioration of the freshwater ecosystems which is caused by uncontrolled discharge of untreated wastewater flows. Water quality decay also results in the decline of tourism perspectives with consequent cut in incomes which are vastly important for developing countries with low national revenue. (UN 2004)

Emergent nations are often addressed with the issue of "bad hydrology", points out Briscoe (2009). The issue is attributed to fragile institutions with insufficient endowments in water infrastructure, rapid growth in water demand, natural disasters and uncertainties which the climate change is frequently responsible for. The consequences are revealed as public health degradation, deterioration of ecosystems, and decline in agricultural and industrial output. At the same time insufficient water availability may raise potential for conflicts between countries and regions. (Jenerette 2006; Briscoe 2009) Struggles over water resources can take place between villages and regions, as well as between land owners and peasants and even between different states. Thus, water scarcity threatens development in the security sector. (Künzl and Barkemeyer 2013)

Constantly increasing due to internal migration urban water demand is considered to be of high priority which leads to intensifying of conflicts among water users (Iglesias 2007). For example, when too many people are trying to get hold of a source which inevitably comes to depletion, the 'prior in time is prior in right' principle may likely increase tension between people and lead to conflicts. (Bruggen 2010)

2.1.3 How is this problem being addressed and what solutions can be found?

It has been presented and proved by no doubt that far more individuals worldwide endure down effects of inadequate and low quality water issues than are affected by wars and terrorism. However, even though the problem of inadequate access to fresh water has rung alarms all over the environmentally-oriented professional media, yet, public interest prefers to be sharpened by politic conflicts and other far less important issues. However, the water crisis is spreading across the world even faster than experts may find time to evaluate it and report to the global community before it is too late. (Lenton, Wright and Lewis 2005) Taylor (2001) made the point clear: "we continue to allocate more money to conflict than to services, prestige projects take precedence over more mundane services, and populations without water and sanitation have neither the contacts nor the power to exert any influence..".

Nevertheless, there are governmental and non-governmental organizations, concerned associations and compassionate individuals around the globe who are concerned with problems of those who stay in the harsh conditions of water issues. Those activists intently research, learn and create solutions for those who cannot manage without help.

One of the most involved parties in water solving issues is the WHO which together with UNICEF collaborates on Joint Monitoring Programme (JMP) for Water Supply and Sanitation. WHO, as the global force on public health and water quality, opposes transmission of waterborne diseases, creates and issues a series of water quality guidelines, including on drinking water, safe use of wastewater, and safe recreational water environments (WHO 2015). Besides, JMP is a primary tool in observing intently the proceeding of MDG water and sanitation targets implementation. Recently, WHO along with UNICEF has summarized the results of JMP after twenty five years of regular assessment and monitoring since 1990 till this year. Figure 2 illustrates progress on reaching the MD goal on drinking water. Globally, in 147 countries the safe drinking water goal has been reached ahead of established time. So far, due to robust work of all the assisting organizations 91% of world population is equipped with improved sources of drinking water. Regrettably, the target has not been met for the least developed countries, though 42% of their population obtained the improved fresh water resource. (UNICEF/WHO 2015)

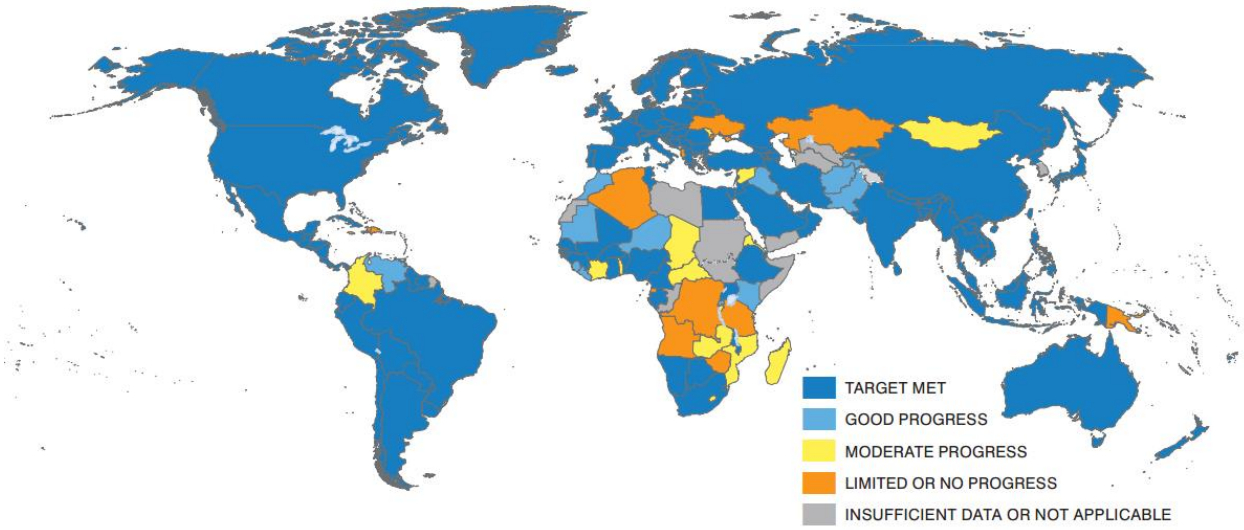


Figure 2: MDG target achievement for drinking water (UNICEF /WHO 2015)

What is worthy of notice is that WHO (2015) has published the paper concerning water, sanitation and hygiene in relation to struggle against the tropical diseases, which has a global strategy on eradication and elimination by 2020 of 17 neglected tropical diseases (NTDs). The document considers supplying of safe clean water, sanitation and hygiene as the main players in achieving of the goal. Later on, by the same organization a report was presented named "Investing to overcome the global impact of neglected tropical diseases" which aimed to confront challenges on the way to reach the targets of WHO's Roadmap on NTDs by 2020. These targets of Roadmap were published in 2011 as a guidance and strategies to support the tackling of the NTDs. The major point of all these documents is that no success is possible on the way to achievement of these targets without solving the water issues.

There are representative non-governmental organizations such as Blue Planet Network, CARE: Water, Charity: water, Global Water Challenge, Humanitarian Innovation Fund (HIF), Lifewater International, Clean Water Fund, The Nature Conservancy, Global Water, PSI:WASH, Safe Water Network, WASH Advocates, WaterAid, Water.org, Water For People, Water Missions International, Winrock International, World Vision: Water and Sanitation, The Water Project and many other ones whose missions to locate, monitor, engage and offer solutions relating to water problems in the world, particularly in developing countries. A well-known online resource "Water for the ages" lists over 80 organizations (as communities, academic, governmental, funding etc.) which perform on water and sanitation issues in multiple countries around the world (H2O Organizations [no date]). Along with these organizations there are hundreds if not thousands of

scientific communities, institutions and universities researching on the world water issues, investigating and researching possible solutions.

For instance, as an international NGO, WaterAid devotes its activities to secure safe domestic water and sanitation for the most impoverished communities of the globe. NGO applies its research and reliable practices to the development of the basic services for the poor. Collaborating with the local municipalities, WaterAid assists community members in operation, maintenance and implementation of various water, sanitation and hygiene projects. (Sachs 2005)

In addressing fresh water scarcity issue, global community enhances its acknowledgement of the fact that access to safe drinking water and sanitation must be recognized within a human rights framework. Namely, in the UN Fact Sheet of human rights the No. 35 'The right to water' (2010) such rights are included in the "Convention on the Rights of the Child, the Convention on the Elimination of All Forms of Discrimination against Women and the Convention on the Rights of Persons with Disabilities". However, the great progress was made in 2002, when United Nations Committee on Economic, Social and Cultural Rights has decreed its general comment No. 15 on the right to water, which is stated as the right for everyone "to sufficient, safe, acceptable, physically accessible and affordable water for personal and domestic uses." But only in the year 2010, the rights to water and sanitation have gained full political recognition through number of resolutions by both the United Nations General Assembly and Human Rights Council, so access to water and sanitation have become a basic human right as a fundamental human need. (UN High Commissioner for Human Rights 2010)

According to the UN ([no date]), the water supply and sanitation facility for each person must be continuous and sufficient for personal and domestic uses. Such uses usually include drinking, personal sanitation, washing of clothes, food preparation and personal and household hygiene. According to the WHO, a person's need is between 50 - 100 liters of fresh water a day. That is the goal to be reached in the developing countries.

Whereas there is a range of water quantity and quality issues in the world, there is a variety of possible solutions found which could be feasible to carry out. However, while in the developed society it might seem enough for many to implement merely water saving approach, in economically undeveloped regions with limited water availability there is an urgent need for other alternative solutions as well, embracing all kinds of additional water resources obtaining.

Undoubtedly, invaluable advantage will be brought by creating equitable and sustainable solutions for the most struggling parts of the world. Hence, in the first lines of global development agenda should be placed on initiatives, such as "imperative to supply growing populations and economies with water in a context of depleting groundwater resources, declining water quality and increasingly severe limits to surface water extraction", claims AUIL review report (2001).

In an outstanding research of Lenton, Wright and Lewis (2005) on the base of UN Millennium Project and its Task force on water and sanitation, authors believe that today like never before world has a chance to better billions of lives by undertaking the range of practical strategies to address the MDGs, implementation of which literally greatly attributes to the delivering access to clean water and sanitation as the prime target. And it stands to reason that aiming for the newly established SDGs will only facilitate the progress .

Further, to the sixth SDG regarded to ensuring water and sanitation availability and sustainable management for everybody, WASH Post – 2015 states that the target cannot be reached unless it is achieved for all subgroups among the global communities. Such remark entails leaving no deprived of the services independently of gender, race, age, livelihood or any other quality or trait. The JMP for water and sanitation attempts to act accordingly to this rule while monitoring progress of the work towards the target accomplishment. (WHO/UNICEF 2015)

Two major concerns were highlighted and answered by the mentioned above Task Force on water and sanitation, such as: (1) "what will it take to expand water supply and sanitation coverage dramatically and sustainably?" and (2) "how can the use of water as a resource be optimized to achieve the MDGs?" (Lenton, Wright and Lewis 2005). Described by the UN strategies particularly identify precise policy measures and executive actions which are believed as the only possible prerequisites for the water and sanitation target to be met. For instance, investments in the sphere of necessary water treatment technologies, development of water management and infrastructure play one of the major roles. These investments and assistance by donor's commitments should be accepted from both of internal and external origins by developing countries' authorities.

What counts in this issue, is that MNCs are offered evolvement in a large scale and new growth opportunities by dealing with new markets of the BoP sector. In realizing this potential, corporations may allocate investments at 'the bottom of the pyramid' which could lead to alleviation of poverty, to social decay prevention, to elimination of political disorders, even to

environmental meltdown, because all these issues are the result of the gap existing between the poor and affluent population. (Prahald and Hart 2002)

Along with the financial contributions and donor aid on the basis of technological development, investments in environmental monitoring and management serve crucial task in eliminating water pollution and battling environmental degradation. Water safety monitoring should be specifically elaborated as major component of national endeavors in the area of environmental sustainability. (UNICEF 2012; Sachs 2005)

Meanwhile, the Task Force of UN Millennium Project has distinguished ten critical actions related to the seventh MDG fulfilment. To not mention all, but two as an example, appropriately fitting for the consideration in the current research, action 8 reads: governments and their civil society and private sector partners must support a wide range of water and sanitation technologies and service levels that are technically, socially, environmentally, and financially appropriate, and action 9 says, that institutional, financial, and technological innovation must be promoted in strategic areas.

Apropos of the eighth action's cause and in addition to suggested by UN corresponding strategies, in their research, Henriques and Louis (2010) derived a decision model formula for the affordable, though still viable and sustainable water technology selection in the supply of potable water and reuse of greywater. This model is to be applied in the developing countries for choosing the right options for municipal water and sanitation services by the decision-makers. In order to design outcome procedure which is able to create feasible options, holistic approach was used, while following essential categories with respective requirements were involved in the capacity factor analysis: technical, social and cultural, environmental, energy, economic and financial, service, human resource and institutional. Figure 3 illustrates the capacity factor analysis model framework developed in the research.

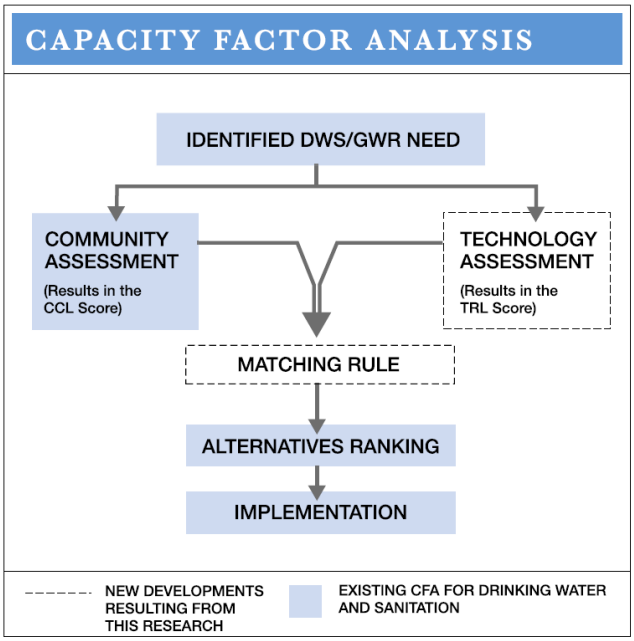


Figure 3: Capacity factor analysis model framework (Henriques and Louis 2010)

This model would be of considerable aid in defining whether a transfer of a particular water treatment technology would be a feasible idea and appropriate option for the developing country.

Technology transfer as concept should be considered as a high priority among practices and technical knowledge shared by international scientific and civil communities as well as commercial facilities. A practical plan to achieve MDG admits, that ample technical knowledge and experience of industrialized countries would serve as a catalyst for positive changes and provide an impulse towards achievement of the Goals (Sachs 2005).

Palaniappan, Lang and Gleick (2008) conducted, probably, the most comprehensive research on reviewing and collecting numerous available decision-making support tools for the selection of appropriate water technologies and practices, meant for the developing world. Totally, 120 effective means and support resources in the WASH sector were evaluated by authors, including various manuals, websites and books. Moreover, 18 of these sources were deliberately reviewed for the in-depth proofing. The results of this robust analysis shed light on the multiple shortcomings of existing resources which, in fact, fail to support decision-makers in an socially appropriate, sustainable, ecological and economical way. It was ascertained that in order to effectively address the needs of developing populations in the WASH sector, practitioners should apply solutions which comply with "an effective user interface; consideration of social implications; regional specificity; information on costs and financing; hygiene approaches; project

replicability; and evaluation and monitoring", because these are the most neglected resources nowadays, the authors claim. According to Palaniappan, Lang and Gleick, the ideal decision-making support tool includes all the essential elements to implement a WASH project, serve numerous languages, be developed in both online and printed forms, and provide a range of successful examples. Also, ongoing dissemination and support systems such as access through libraries and the Internet, regional workshops and on-call technical support groups are vital.

In selection of appropriate water and sanitation technologies the costs of their implementation may be significantly reduced by applying low-cost options at every place where it is possible. The point is that basic services brought by such low-cost technologies would not differ in quality from more advanced and expensive ones, but the means of installation would not exceed available funds. (UN 2004) Unfortunately, often destitute of this logic, donor agencies and confused by choices decision-makers do not follow this principle, and therefore large amounts of population are left unserved.

In this context, it is always essential to weigh how expenditures can be effected by the choice of various technologies in early stages of a project. Tentative budget estimates for various levels of sanitation service and corresponding water treatment technologies are illustrated by the so-called 'ladder of sanitation options' (Figure 4). It is also important to understand the difference between 'basic' and 'improved' facilities as well as between "(mostly non-networked) rural sanitation component of the target on sanitation and the (mostly networked) urban improved wastewater treatment component", indicated UN (2004).

As a matter of fact, a lot of fiscal calculations and discussions of the projects suggested by decision-makers often do not consider presence of wastewater treatment and reuse options and collection systems, and hence, costs of environmental stress which is generated by these exclusions are also omitted. In this respect, and having in mind the fact that some low-cost options may also contribute to the environmental degradation, decentralized, cost-effective and ecologically-friendly water technologies should be the prime alternatives of high priority to conservative centralized options, either in rural or urban areas. (UN 2004)

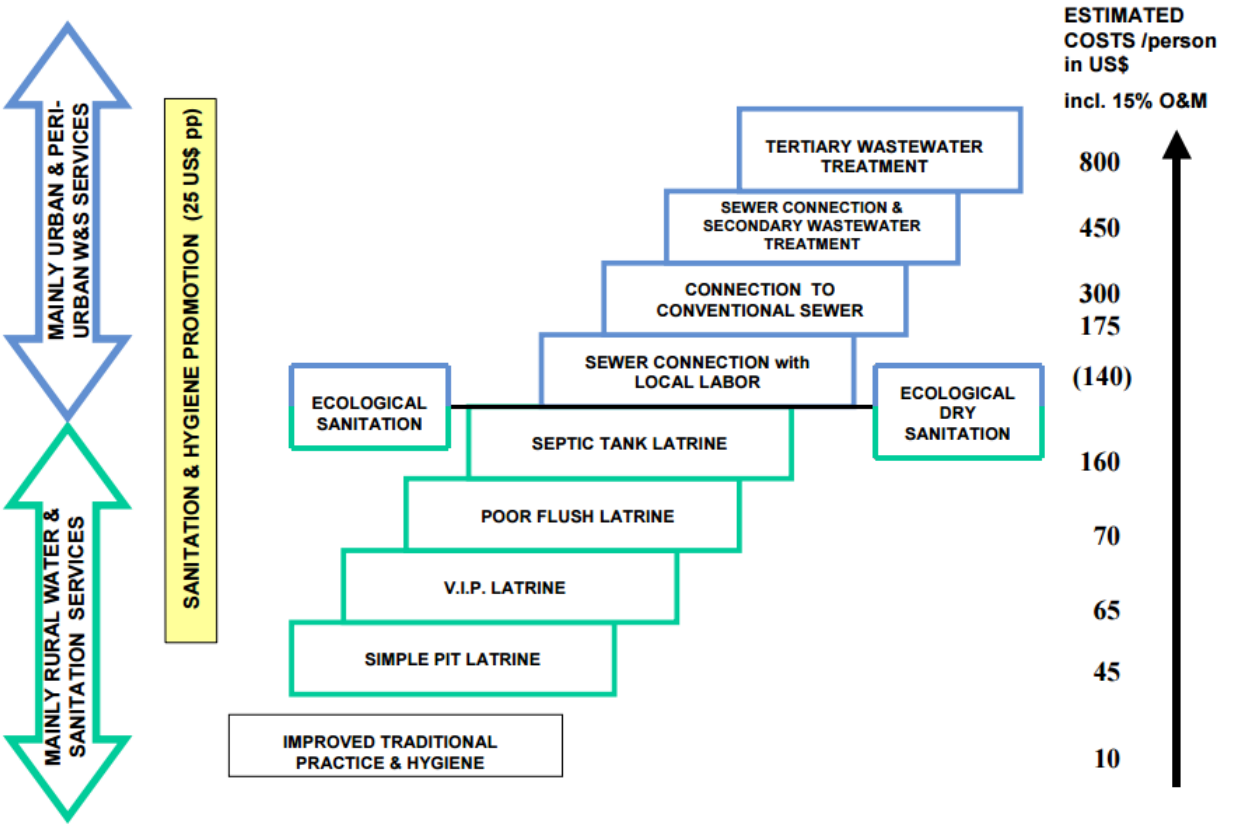


Figure 4: A 'Ladder of Sanitation Options including basic level and stepping up to the modern ones. (UN 2004)

It is worth to mention, that applying the estimated values of WHO, Henriques and Louis (2010) have calculated that in order to fund the operation of creating completely new access to water for every single person in the low-income countries, merely 0.09% of global GDP would be sacrificed.

Nonetheless, the actual state of affairs is presented, for example, by the Organization for Economic Co-operation and Development (OECD). It reports statistics on monetary scale of assistance in water supply and sanitation, delivered by industrialized world to developing countries. The aid served as one of the instruments for supporting MDG seventh target accomplishment. In 2010-2011 among major contributing parties were Japan (on average USD 1.8 billion per year), Germany (USD 868 million) and the United States (USD 442 million), while IDA provided USD 1.3 billion and the EU Institutions USD 538 million. Overall aid counted for about USD 7.6 billion. (OECD-DAC 2013) Figure 5 represents financial commitments of external aid to water and sanitation during nearly four previous decades.

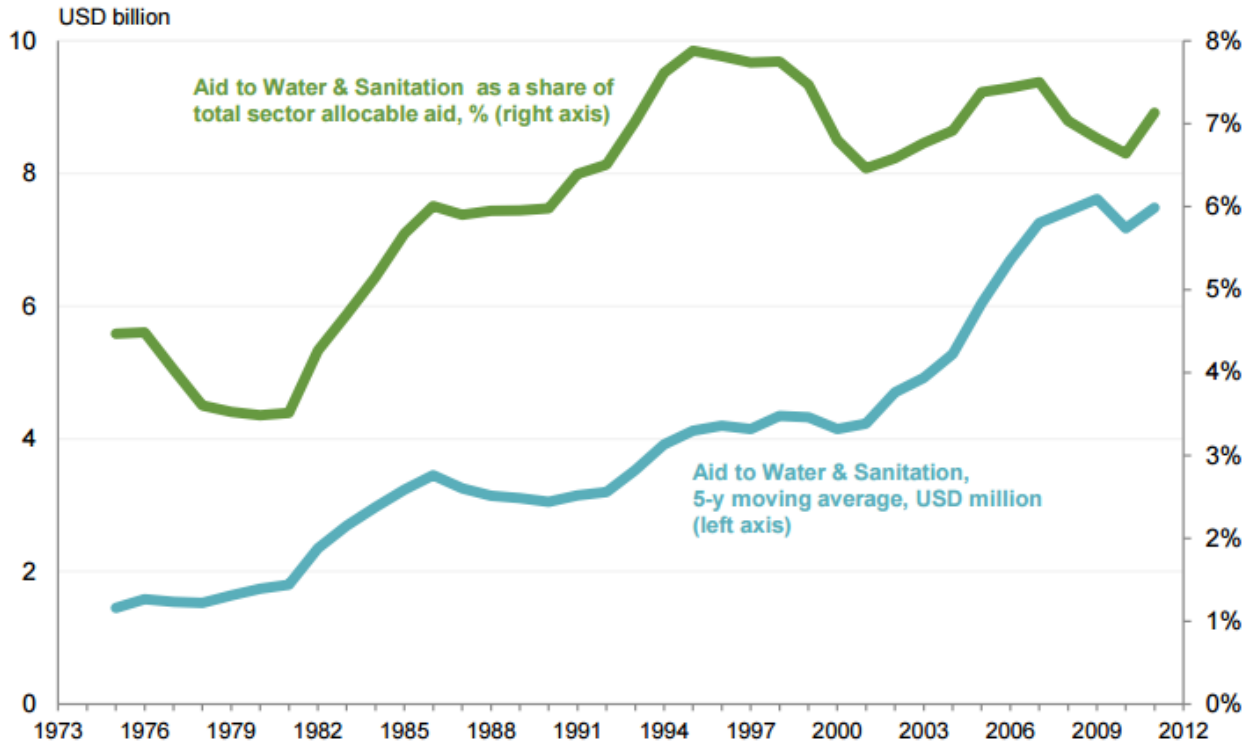


Figure 5: Statistic data on aid to water supply and sanitation in developing countries, 1973-2013 including 5-year average contributions, constant 2013 prices (OECD-DAC 2015)

UN (2004) gives estimates of 80 billions dollars per year utilized for total expenditure in the water sector of developing and transition world including all the foreign and internal aid contributions. Of these, drinking water treatment and supply, sanitation and hygiene deduct nearly 14 billion and approximately same amount is dedicated to municipal wastewater treatment annually. Also, next three major sources of funding are identified for water sector in general:

- International Transfers (Official Development Assistance (ODA) and international lending from development banks and commercial banks);
- Private Sector Investments (International and domestic);
- Other Domestic Sources (budgetary allocations, domestic lending and user finances). (UN 2004)

Water provision and distribution is a very complex process in developing countries. Numerous households in the poor communities do not possess a luxury of using piped water networks. This is because government and local administration is left responsible for the identification and supply of potable water to the citizens. (John et al. 2014) However, inadequate management of water resources by governments of developing countries underlies deficiency and unequal distribution of available water resources among the population. In spite of the fact that governments have an ownership of water assets, and in a number of circumstances completely control its administration, the record of its beneficial work is very poor. The lack of arrangements and proper planning is

explained by low motivation to maintain water systems, to involve technological innovations and to compromise on marginal costs of water for poor. Traditionally municipal tariffs are established under cost recovery levels, which is less than half of paid water supply, therefore big portion of inhabitants live with no official services. For that reason most of the world is on the way to change this institutional fault, however 3rd world countries are the last to aim such goals. Water resources management indubitably should be spread to different forms of private sector entrepreneurship. (World Bank 1994; Rivera 1996) Apart from the fact that majority of people in developing countries have low income and might not be able to afford paying for treated piped water, another impediment exists for rural dwellers: authorities often fail in supplying water to remote residents which can be caused by lack of incentive and could not be economically cost-effective to build a pipeline to far away locations. To deal with this difficulty a private enterprise might structure contracts with villagers. Contracts might cover conditions of universal supply by piped water of all residents within an agreed area. However it is the government who should take care of low income dwellers and provide corresponding subsidies to ensure that all poor have got the right to water services. (Baumert 2004)

Cowens (1998) have made a deliberate analysis on deregulated water supply as a policy option for developing countries. In their opinion, the poor cannot afford safe sources of water because of the lack of enterprises offering such services or the impediments in costs set by government owned companies. These difficulties are likely to lead into destructive economic and social repercussions. Authors suggest unregulated, privatized monopoly as a potential policy advancement, which under particular circumstances could bring one of the best solutions across the quality and quantity of output as well as reliable water supply for people. While majority of the population in developing nations don't have formal water hook-ups and piped connections, they must resort to other, often unsafe options. Another reality is that if an individual wants to buy a water from nonpiped source, it comes to 10-20 times more expensive than the cost of water through the pipes. For example, it was revealed that in 8 major cities water vendors charge prices 8–16 times those charged by public utilities, and another example says that in a scale of 47 countries mobile vendors offer ten times more expensive water services compared to the piped water prices. (Hammond et al. 2007) What is important, the issue is claimed to be rather institutional than technological. Due to low tariffs at levels below cost recovery established by governments, the water utilities feel dissuaded in delivering services in a big scale, especially to the areas of low-income households. But the human costs of these governmental settlements highly expressed in severe death rates due to consumption of hazardous waters. To fight with the causes of too many deaths the Cowens offered inclusion of

unregulated privatization as fifth addition to the four already existing institutional regimes in the world: “outright public provision of water (common throughout the world), government-supported natural monopoly with regulated price (the English model), government-supported natural monopoly with regulated rate of return (the American model), or a government-controlled franchise, lease, or concession agreement (the French model and its variants).” The emphasis of the proposed alternative is on the “complete privatization of water assets and unregulated natural monopoly”. The considerable advantages of the suggested regime described in the research comprehensively. Despite possible difficulties in cost bargains, impaired government credibility, rent-seeking charges and partial exclusions, potential benefits may excel these drawbacks, hence the policy deserves to be seriously examined as an alternative in water sector. (Cowens 1998)

Measures against over-extraction of ground water resources were analyzed by Danh and Khai. Their research studied household demand and supply for clean groundwater in the Mekong Delta, Vietnam with 18 million inhabitants and its extensive need for clean water. Conducted study revealed that using available so-called groundwater supply units (GSU) instead of conventional methods of obtaining water would prevent groundwater overuse. The network of GSU has been established mostly in rural areas by Water and Environment Management Centers (WEMCs) via collaboration of Vietnamese authorities with UNICEF. The operation of GSU was compared with the popular private tube-wells, which are shallow in depth and get easily worn-out or contaminated by chemicals as fertilizers and pesticides from agriculture. In addition, the access to private tube-wells is not controlled, thus, their number spreads too fast to maintain groundwater level in sustainable way. One of the consequences of over-extraction appeared to be saltwater intrusion which can result in fouling of whole groundwater aquifer. Nowadays, the operation of GSU is claimed to maintain adequate groundwater level and prevent them from depletion. (Danh and Khai 2015)

Another approach to secure ground water basins is following. Apart from discrediting the concept of safe groundwater yield, Alley and Leake (2004), Ponce (2007) and plenty of other researches consider the aspect of sustainable yield which implies rational use of the resource, based on a compromising policy of little or zero sustainable withdrawal and seeking the balance between dry period’s enhanced use and substantial replenishment in the times when water is available from alternative sources.

In the light of rapidly growing developing world’s population and urbanization, Zektser and Everett (2004) assertively point out the necessity of facing the consequent challenges to protect

not only quantity but also the quality of urban ground water. They emphasize, that to manage with the task, authorities are obliged to begin with baseline data collection through government agencies, institutions, NGOs and university departments.

Making the water supply ubiquitous and available for all appears to be a long-term objective. However, depending merely on resource- and time-intensive centralized options such as piped connections, immense amount of individuals will be left with no survival instrument for indefinitely long period of time. Moreover, implementation of centralized large-scale water treatment systems and supply networks established by local governments in the poor regions, turns out to be costly option, while the installation progress usually is very tardy. To add to it, installation of large-scale water treatment facilities in the rural areas of developing countries would be economically unfeasible. (Varghese 2004) Hence, low-cost, self-sustaining, decentralized solutions with fresh drinking water as outcome should be implied in the areas of unreliable municipal water supply as soon as possible. Those solutions may include safe storing of water, point-of-use chemical and solar disinfection treatment, as well as behavioral change. Point-of-use technologies and products are commonly simple to use and are estimated to prevent 30-40% of all diarrheal diseases (Fewtrell 2005, p. 48, cited in Vousvouras and Heierli 2010). Applied, these approaches have the power to alleviate lives of hundreds of millions of dwellers in developing countries, to contribute to development and productivity, to improve drastically health outcomes let alone mitigate mortality. (Mintz et al. 2001; Varghese 2004)

The growing challenge for water management in developing countries is inflicted by climate change. To tackle aggravating water issues Mujumdar (2013) suggests to apply well-formulated adaptive options. He considers climate change as a challenge which brings broad amount of opportunities for water governance to modify existing water systems. Together with resilient adaptive approach engineering intervention should be executed in large scale. Extension of approaches should concern all essential measures such as local rainwater harvesting, reviving the village tanks, adoption of small-scale practices and wastewater recycling methods. Meanwhile envisaging further development of water systems should involve correcting irrigation technics, turning flood waters into advantage in the resource, increasing infrastructure patterns and storage volumes, adjusting agriculture management and elaborate on desalination methods. In case of droughts, competently built groundwater basins should secure utility of water systems. Mujumdar emphasizes that climate change conveys enormous responsibility on the water management authorities of developing countries, who should very deliberately and thoughtfully evolve conjunctive use policies against surging water problems.

A group leader in the Sehgal Foundation (2014) Lalit Sharma reveals a vulnerable spot which challenges the water management in rural areas of India. He notices that there is a lack of concern about water demand management whereas the supply is targeted well by development teams. Demand administration includes policies, measures or other initiatives which serve to control or restrict the demand for, the use of or waste of water supplies or other water services (Butler 2006). Supply focuses on the delivering water through investments in water projects, combined with engineering and technical expertise, to capture, store and deliver water and to make systems operate effectively (FAO 1993). The point of Sharma is that it is equally necessary to address demand side as well as supply side in order to reach equilibrium. To work on both supply and demand sides of water management is the approach of Seghal Foundation. The thing is, if only supply's side implementations is done by increasing of water available, it will result in more demand which will correspond to more consumption. For example, having more water at farmer's disposal, the growing technics can shift to water-intensive, which for its turn will likely worsen the seemingly advanced situation. That is why the water supply and demand have to be addressed as one. (Sharma 2015)

In the process of managing water resources entire connection of societal, environmental and agricultural systems should be regarded as one. Where needed, legislation must ensure a fair allocation of water sources. For instance, in order to alleviate pressure on the availability of water in some regions and to prevent excessive withdrawal from surface and ground waters laws should determine amounts of water which meet the needs of either individuals, or industries, agricultural sector, urban areas. (Alley et al. 1999)

Whether a lot of promising methods may be yet applied in water management of a country towards obtaining essential amounts of the resource, there is an increasing number of regions where water is literally unavailable for alternative extraction, and in order to survive populations must resort to implementation of sustainable water reuse techniques.

For example, domestic wastewaters or agriculture irrigational outflows nowadays can be effectively treated in different scales with varying levels of outcome water quality, so water can be reused in a number of scenarios. (Gündüz 2015)

Natural anomalies and anthropogenic stresses have a decisive and crucial contribution in the success of appropriate quality and quantity water supply. Today, humanity has to either resort to previously unused water resources, or appeal to advanced technologies and treatment methods on the way to rational and sustainable resource utilization. Reuse of wastewaters begins to play critical role in water resources management, especially in developing world which is becoming more and more distressed by potable water scarcity every day. (Gündüz 2015)

For the achievement of meaningful public health improvement and eradicating social issues of the poor in economically undeveloped world, affluent industrialized countries set up numerous international assistance agencies, such as UN affiliates, multilateral development banks and Bilaterals. These departments have invested considerable amounts to support finance planning and construction of community sewerage and water supply facilities in the developing regions. Nonetheless, majority of these great efforts turned to be worthless, principally due to misunderstanding by the assistance workers the design criteria for the projected facilities, which must be transformed to fit the socio-economic status of developing countries. Given the amateur state of economic development and scarce availability of finance resources in the developing countries, it is hardly possible to emulate Western design practices and follow the environmental standards of the developed world. It is particularly difficult in relation to operation and maintenance of the projects, therefore rendering approaches must be simplified. (Harvey 2003)

To date, in order to make plans for investments with possible international support, there is an urgent need in developing countries for political and military stability, as well as for elimination of corruption. Population growth reducing programs should also be involved, as well as control of urbanization flows. Furthermore, water management authorities should concentrate on accurate evaluation and estimation of limitations to natural water resources. (Bruggen 2010)

Alrusheidat (2004) made a special reference in his work to the significant role of environmental education among populations. Learning what consequences are brought by unsustainable water treatment is crucial in insuring of sustainable development by taking responsibility and restraining further environmental degradation caused by human careless activities. Accent should be put on altering people's attitude and directing way of thoughts to the causes and effects of environmental problems. Author emphasizes that the only way to change human's perception about environment is to teach him about it, which is, obviously, logical, none the less, educating in the environmental issues has never been given credit for, and capabilities of such education have been disregarded. Alrusheidat suggests that "The development of environmental education as a discipline must draw knowledge from many other scientific and technical fields such as ecology, biology, information management as well as curriculum development of schools, community colleges and universities." What is especially important, environmental education in developing countries should be spread by the help of international organizations or any other institution acting in the area of environmental problems. Delivery of environmental information to the people contributes to the knowledgeable and rational management of the available natural resources. Considering critical

scarcity of water resources in the undeveloped regions, enlightenment of the population as well as transferring the teaching of efficient practices and technologies will bring considerable improvements in the water issue condition.

Prüss-Üstün et al. (2008) declares that the likelihood of world's diseases eradication by advancing availability of clean water and sanitation as well as sustainable development of water resources management may account for almost 10%, while aggregate death rate could be eliminated by over 6%. Besides, an important point is that according to Montgomery and Elimelech (2007) as well as Nath et al. (2006), improving access to water and sanitation is considered to be the most productive, relatively attainable and economically advantageous way to reduce global public mortality and morbidity concerns. Respective measures should be implemented world-wide, however, the most acute attention should be given to the emergent regions, where the situation, obviously, is much worse than anywhere else on the planet.

To address the disclosed problem of animal agriculture's water footprint, comprehensively discussed in the part 2.1.1 of this paper, we shell come across following scrutiny.

When thinking about the global water footprint and the role that agriculture has, it is paramount to distinguish it from the industrial and domestic water footprint to understand the importance that it has. Diet is one the biggest factors in wasteful personal water usage, which could be largely diminished by more intelligent dietary choices. Apart from highly increased need for more water, the waste produced by animal agriculture damages the quality of natural water resources. Comparing the graphic demonstrations in figures 6, 7 and 8 helps to visualize the role of agriculture among the global water footprint.

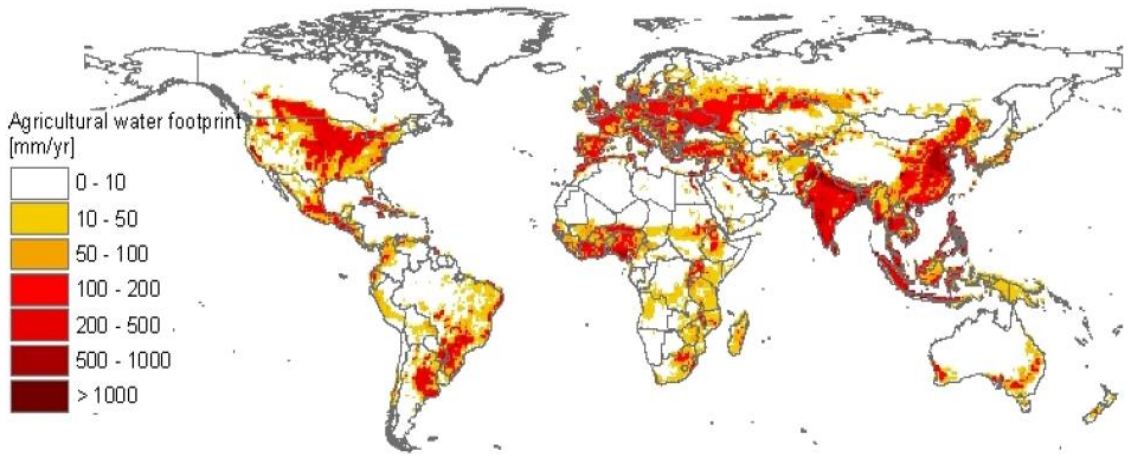


Figure 6: Global agricultural water footprint. (Mekonnen & Hoekstra 2011)

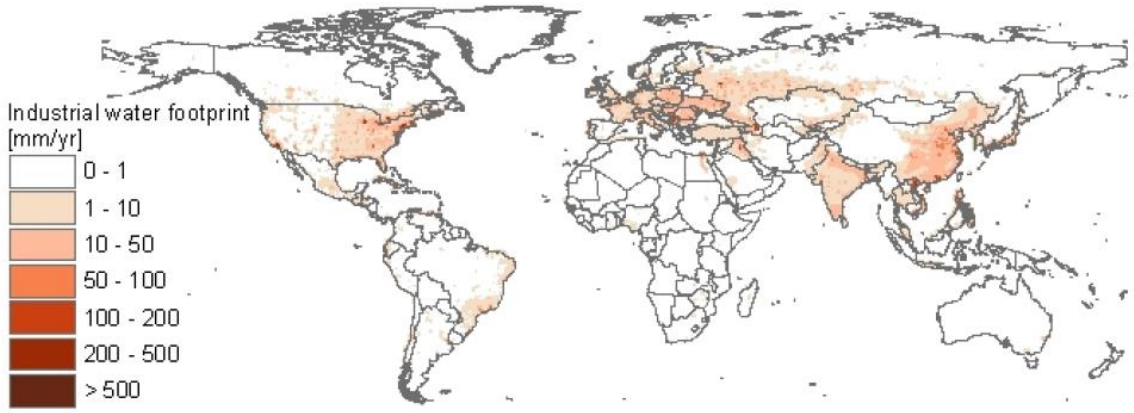


Figure 7: Global industrial water footprint. (Mekonnen & Hoekstra 2011)

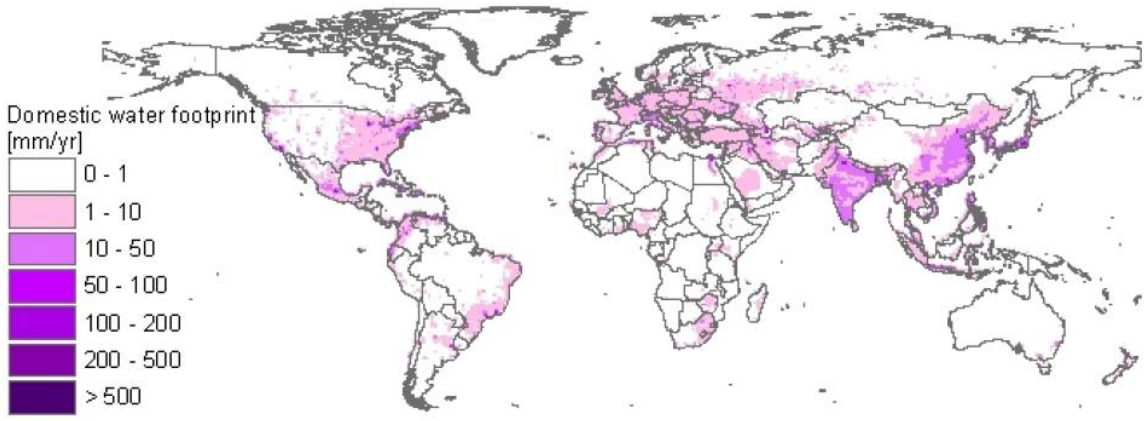


Figure 8: Global domestic water footprint. (Mekonnen & Hoekstra 2011)

It is easy to see that the domestic and industrial water footprints are significantly smaller than that of agriculture. Commonplace methods that individuals can perform for saving water, like closing faucet while applying soap in shower or brushing teeth and home appliances that comply with low energy and water use ratings, or any other of various kinds implemented in both developed and developing worlds, can be incomparably shadowed by diet without meat and dairy products. Adding a single ¼ pound (113 grams) piece of beef to a person's diet per day will increase daily water usage by 450 gallons (1703 liters) per day. Estimates show 1799 gallons (6809 liters) of water per each pound (0.45 kg) of beef produced (USGS 2004). The global average is a little higher, 15 415 liters of water per kilogram of beef (Hoekstra & Mekonnen 2012). In a family of four people this calculates into at least 8327 liters of water per day for the family. On the opposite end of the scale eating a 1 kg of starchy roots (potatoes, yam, carrots etc.) has a water footprint of 387 liters per kilogram (Hoekstra & Mekonnen 2012). In a family of four, if each member eats a

whole kilogram of starchy roots, this averages at 1548 liters of water in water footprint. Still less than that small 113 g piece of meat for only one person. To put that into perspective the household water use in developed countries is on average 307 liters, and in developing countries 44 liters of water per capita per day.

Mekonnen and Hoekstra (2011) have determined that domestic water use forms only 4% of the used water (Figure 9). Therefore the possibility of significant reduction in total water use is impossible in the domestic sector. Hoekstra states that the research which he co-authored (Mekonnen & Hoekstra 2011) implies that roughly 27% of water footprint created by humanity is a result of animal products. This figure is partly formed by water footprint of grains that were used as animal feed. For example, in between years 2001 and 2007 FAO (2011) estimates that on average 37% or the cereals produced in the world ended up as feed for livestock (Hoekstra 2012).

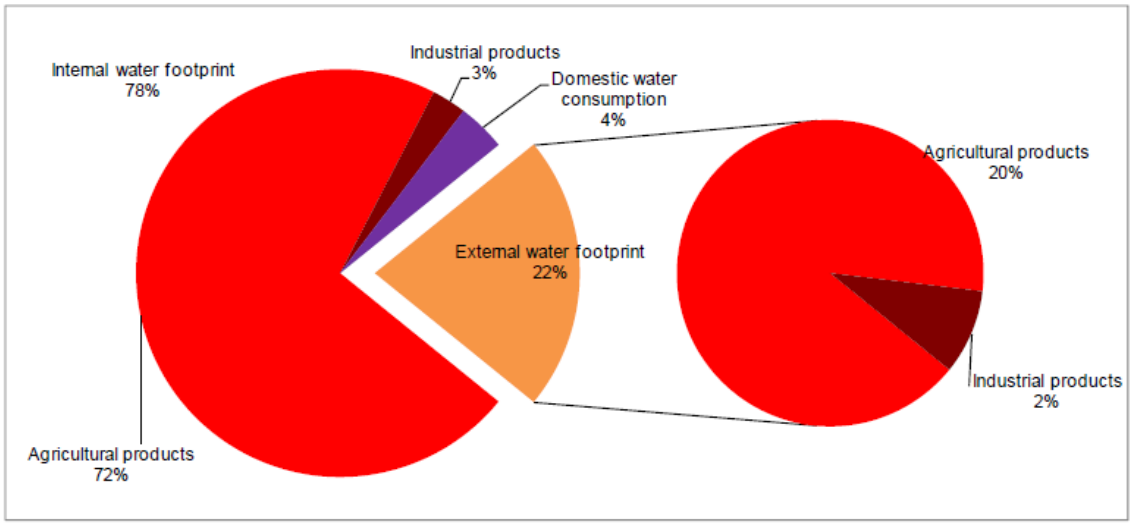


Figure 9: National water flows divided into contributing categories, and internal and external footprints. (Mekonnen & Hoekstra 2011)

If the whole world population would remove animal products from their plates, these 27% (Mekonnen & Hoekstra 2011) would decrease to nearly nothing. In case if the change towards a completely plant-based diet would be incremental, the scale of saved water would be easily many times greater than that of domestic water savings. Halving the domestic water use from the current would result in savings of 2% in total water usage. Then again, halving the use of animal products would result in a decrease of 13.5% in total water usage. This gain would be easy to achieve by simply eating no meat and dairy products on every other day. The fact that the developed countries have not yet achieved such a high level of animal products consumption would make one to presume a difference of water use between the developed and developing countries. However, we must take into consideration the fact that wealthy countries hugely participate in the creation of water footprint in developing nations by growing and exporting livestock and agricultural

products. International agricultural corporations outsource a share of their production to low-wage nations to minimize expenses by using cheap labor and resources. Affluent western nations effectively impose their will and dominance of resources over the dire need of third world nations who are suffering from severe water shortages and famine. The farming of exported crops and animal products puts a strain on the environment of the developing country, simply to produce goods for developed worlds, which have greater purchasing power.

United States Department of Agriculture has stated that agriculture accounts for approximately 80% of the whole nation's water use (USDA 2015). If even the most developed of western countries with the largest recorded water footprint owes so much of its water consumption to agriculture, one can easily see the minimalist and ascetic conditions in developing countries make role of agriculture even more profound. Therefore it is safe to say that by significant water savings in the agricultural department most nations would also benefit from remarkable improvements in their total water usage. Hoekstra (2012) estimates that in the industrialized countries a vegetarian diet could reduce the food-related water footprint up to 36%. Moreover, one could also go much further with a vegan diet.

Considering the inefficiency of water use in feeding animals with crops which are perfectly edible for humans, one can conclude that the production of animals for food is likely to be the least efficient use of water, land and food available. In his paper Hoekstra states (2012, p. 6) that "The numbers show that the average water footprint per calorie for beef is 20 times larger than that for cereals and starchy roots". This makes it hard to justify such wide use, or waste of resources in the world consuming patterns. In Table 2 the water footprints between plant foods and animal products are compared.

Table 2: Crop and animal products with global-average water footprint. (Hoekstra & Mekonnen 2012)

Food item	Water footprint per ton (m^3/ton)				Nutritional content			Water footprint per unit of nutritional value		
	Green	Blue	Grey	Total	Calorie (kcal/kg)	Protein (g/kg)	Fat (g/kg)	Calorie (liter/kcal)	Protein (liter/g protein)	Fat (liter/g fat)
Sugar crops	130	52	15	197	285	0.0	0.0	0.69	0.0	0.0
Vegetables	194	43	85	322	240	12	2.1	1.34	26	154
Starchy roots	327	16	43	387	827	13	1.7	0.47	31	226
Fruits	726	147	89	962	460	5.3	2.8	2.09	180	348
Cereals	1,232	228	184	1,644	3,208	80	15	0.51	21	112
Oil crops	2,023	220	121	2,364	2,908	146	209	0.81	16	11
Pulses	3,180	141	734	4,055	3,412	215	23	1.19	19	180
Nuts	7,016	1367	680	9,063	2,500	65	193	3.63	139	47
Milk	863	86	72	1,020	560	33	31	1.82	31	33
Eggs	2,592	244	429	3,265	1,425	111	100	2.29	29	33
Chicken meat	3,545	313	467	4,325	1,440	127	100	3.00	34	43
Butter	4,695	465	393	5,553	7,692	0.0	872	0.72	0.0	6.4
Pig meat	4,907	459	622	5,988	2,786	105	259	2.15	57	23
Sheep/goat meat	8,253	457	53	8,763	2,059	139	163	4.25	63	54
Beef	14,414	550	451	15,415	1,513	138	101	10.19	112	153

Botswana is a great example of a developing country that is starting to suffer from so called ‘water stress’ in respect to animal agriculture. As its economy is still rather underdeveloped, Botswana has only around 23% of its total water consumed by the livestock. This could easily increase significantly with a booming economy, as consumption would follow increasing income. Most of the used water, around 65% from all available water, comes from groundwater resources. Botswana is not a very rainy country and that means that the rechargeable volume of the groundwater is low. Only 0.4% of Botswana’s renewable resources is rechargeable groundwater. Low recharge combined with the increasing amount of boreholes which is more than permitted to feed the already increasing number of grazing livestock results in dropping levels of groundwater table. This progression cannot be called sustainable and in the long term will lead to a water crisis. (Steinfeld et al. 2006)

Wealthy western nations, such as the USA, use vast amounts of water compared to their third world counterparts. To give some perspective, the difference between even two advanced nations, such as China and USA, can be great. USA averages 575 liters of water per capita per day, as China only averages 86 liters per capita per day. (UNDP 2006) This means China consumed roughly only 15% of the USA consumption of water per capita in 2006. These figures include nations complete use of water, shared per capita, and the gap tends to shrunk since China is constantly progressing toward the consumption habits of the western world. If the rest of the world will follow the same footsteps, the strain on the environment will not be sustainable, in fact, the situation is already seriously threatening. Developing countries especially have the biggest potential to harm the environment even further, when closing the gap in water consumption

between themselves and countries like the USA. On the Table 3 we can see in growth percentage of developing and developed world. Comparing this growth with per capita consumption gives you an idea of how consumption in the developed world has nearly reached a plateau but will continue to grow in the developing parts of the world. (UNDP 2006; Alrusheidat 2004; Delgado 2003)

Table 3: Projected growth of meat and dairy consumption in certain countries and parts of the world. (Delgado 2003)

	Projected annual growth 1997–2020		Total consumption in 2020		Per capita consumption in 2020	
Region	Meat	Milk	Meat	Milk	Meat	Milk
	(*%/y*)		(*million metric tons*)		(*kg*)	
China	3.1	3.8	107	24	73	16
India	3.5	3.5	10	133	8	105
Other East Asia	3.2	2.5	5	2	54	29
Other South Asia	3.5	3.1	7	42	13	82
Southeast Asia	3.4	3.0	19	12	30	19
Latin America	2.5	1.9	46	85	70	130
of which is Brazil only	2.4	1.8	20	30	94	145
WANA	2.7	2.3	13	42	26	82
Sub-Saharan Africa	3.2	3.3	11	35	12	37
Developing world	3.0	2.9	217	375	36	62
Developed world	0.8	0.6	117	286	86	210
World	2.1	1.7	334	660	45	89

Trying to change the learned habits of high income countries will always be difficult since the absence of animal products is associated with being poor. Avoiding such a cultural effect will be beneficial in terms of swiftly minimizing the water footprint in developing countries. Abandoning animal agriculture practices and changing to the plant based diet would bring indispensable advantages in water availability and water quality preservation, let alone entire ecosystem.

In the present day water scholars, academic researchers, engineers, activists and professionals all together are responsible for world water preservation and maintenance, and their most acute attention should prevail among the water issues of developing countries, where the water challenges threaten lives of millions and therefore must be solved as soon as possible by

environmentally sustainable and economically feasible ways. However, in order to prevent the development of water crisis in the first place, humanity should choose their lifestyle courses and habits wisely, with the careful attention to the environment which they co-exist with, especially to the water resource.

2.2 Mapping existing technologies and products of water purification in BoP markets

Nowadays in some locations of both urban and rural areas of developing countries populations may have access to sufficient amounts of water. However, dirts, chemical and microbial contaminants make that water useless for consumption purposes. (Clasen 2015) Therefore, the number of viable water purification products and technologies are needed to be developed and applied urgently, especially in the places where water scarcity is the critical issue.

Since the range of technological methods and scope of technical equipment with respect to water treatment differ immensely depending on the extent and nature of contamination as well as on the degree, to which water is to be purified or intended purpose of use, we are going to attain merely superficial knowledge about some specifically drinking water purification technics and products.

Technologies and products for drinking water purification can vary greatly in principle, scale and affordability. Since the residents in the BoP market have limited funds, it demands us to inspect the water purification commodities that could address affordability by consumers. Certain advanced and unnecessarily costly technologies and products will not be taken into consideration. Interest will be given especially to the most economically efficient, easily portable and simple to use solutions. This is because of the fact that BoP markets can often have bad logistics and uneducated end users in addition to the factor of common poverty.

One of the most burdensome problems to provide safe water in the BoP sector is the budget requirements to attain the planned objectives in, firstly, choosing the most appropriate water technology or product for an area, and secondly, applying these on the ground. Hence, assigned professionals and decision-makers must be very discerning in implementing these practices.

Taking into account that the costs of water technology development and implementation is the biggest hindrance in the developing countries, selection of the technologies is quite limited. Besides, a technology should be not only affordable, but also suitable for the use by the poor in each particular region, considering tasks of maintenance, repair service, conditions of the

environment of the installation place and so on. Still, there is a number of appropriate methods for water disinfection in developing countries, and all of them have its own benefits and drawbacks.

While centralized water treatment plants is a standard tool to deliver safe water to consumers in the industrialized world, it is an unrealizable idea for the majority of the BoP consumers. That is why point of use (POU) water treatment technologies have been found suitable for the BoP population, in particular rural inhabitants. According to Rajshree et al. (2013), POU gravity-driven household water purifiers were proven as a simple, low-cost and effective solution for reducing the impact of waterborne diseases in undeveloped nations. Most of these purifiers utilize chemical disinfectants due to their low cost, convenience and ability to work under gravity without need for electricity or piped connections, which is very applicable for the poor. The research of Rajshree et al. has compared various types of water disinfectants and has led to conclusion that the most suitable ones for the end users of developing countries are substances based on liquid bromine, iodine, $Ca(OCl)_2$, and NaDCC, which are "expected to be cost effective (US$3.60–6), of acceptable size (1–2 L) and weight (0.7–1.4 kg) and are thus expected to be ergonomically and economically attractive".

However, newly conducted study by Liu, Tang and Liu (2014) have asserted that nowadays nano-materials in POU systems are proven to overcome the disadvantages of traditional water treatment methods such as chemical disinfection with chlorine and related agents, while holding implementation costs down. The drawbacks of chemical purifying were estimated by WEF (1996), Braghetta (1997) and Krasner et al. (2006) as following: "(1) long treatment time to get rid of bacterial pathogens; (2) consumption of a significant amount of chemical agents; and (3) side-effects from the formation of harmful disinfection byproducts, e.g., carcinogenic trihalomethanes" (cited in Liu, Tang and Liu 2014). In contrast, nanotechnologies can be applied for economical and efficient POU systems while avoiding the mentioned problems of the chemical compounds in relation to water purifying. Thus, novel POU based on nano technologies, such as nanosilver textile water disinfection kit, could be a new, better solutions for the promotion in developing countries.

Apart from the nano technologies, water purification in the BoP sector can be reasonably done by solar distillation or solar pasteurization, slow-sand filtration, reverse-osmosis and hollow fiber filtering.

As for the solar water disinfection, Vivar et al. (2010) have suggested that systems employing photo-catalysts and UV radiation have been proven as one of the best suitable options for urban and rural areas of developing countries with the problematic access to electrical power. Moreover, the integration of such systems can be implemented with clean, renewable electricity generation

in the water purification system. In particular, Vivar et al. have developed a new concept for an autonomous, cost-effective hybrid water purification and photovoltaic system for meeting the needs for both, safe water and electricity. Urban regions of the BoP population can be specifically addressed with this technology due to specific needs of its large market.

A number of water disinfection alternatives have been evaluated by Burch and Thomas (1998) on the basis of normalized costs and appropriateness, taking into consideration that reported costs were applicable to developing world. In the Annex 3 summarized results of the research can be found.

Also, Burch and Thomas have carried out a comparison of disinfection methods for small water systems applied in the village communities of developing countries. Results can be seen on the Table 4.

Table 4: Comparison of disinfection methods for small water systems (Burch and Thomas 1998 cited in Gadgil 1998)

	Roughing filter + chlorine dosing plant	Roughing filter + grid-powered MOGGOD	Roughing filter + slow-sand filter	Roughing filter + grid-powered UV	Roughing filter + PV-powered UV	Batch-scale chlorine for home	Boiling at home with purchased fuel
Operating cost, US cents per m^3	7	58	3	3	15	9	2083
Effectiveness							
Residual	High	High	Nil	Nil	Nil	High	Nil
Against bacteria & viruses	High	High	High	High	High	High	High
Against protozoa and worms	High	High	High	High	High	Med.	High
Ease of Use							
Supply chain independence	Low	Medium	High	High	High	Low	High
Independence from need for skilled labor	Low	Nil	High	Medium	Medium	High	High
Independence from need for unskilled labor	Low	Medium	Low	High	High	Medium	Low

Products of water purification for the BoP markets

Inspected products are following:

- Biosand filter (slow-sand filtration)
- LifeStraw® (sortable hollow fiber filter)
- SlighShot water purifier

- LIFESAVER jerrycan
- Watercone® and Solarball
- Pressurized recharge wells
- Ceramic filter
- Chemical purifiers (Aquasure & Pureit)
- Aqualite™ System

Biosand filter is an affordable slow-sand filter, based on common materials, that is already widely used. The filter is a roughly 3 feet, or 0.91 meters, tall. It commonly consists of an outer concrete shell (figure 10), which could also be replaced with an oil drum or plastic bins to recycle these materials. This filter tower has a diffuser plate at the very top, which prevents the poured water from damaging the filtering layers below. As the water drops down gently, the first filtering layer is the so called 'biolayer'. Fine sand does the mechanical filtering of pathogens by trapping them in the space between the grains of sand, and it takes up most of the height of the entire filter. The height of the sand bed of course a factor in the filters efficiency. For example the height of the sand bed was tested with 0,73 and 0,40 meters, which gave the average removal percentage of total coliforms to be 99.30% and 98.70%, respectively. As seen in figure 16, at the bottom of the filter is separating medium grain-size gravel layer, which blocks the sand from clogging the outlet tube embedded among the even rougher drainage gravel layer. The efficiency of the biosand filter isn't at the same level as other more sophisticated methods, but it is nonetheless effective help for people threatened by waterborne diseases. Biosand filters have been attributed to the overall decrease of diarrhoeal diseases in Ghana by 60%. Other studies executed in Dominican Republic and Kenya indicated a reduction of 47% and 54% in diarrhoea risk. (Biosand 2003) One of the negative aspects of Biosand filters is its inefficient removal of viruses.

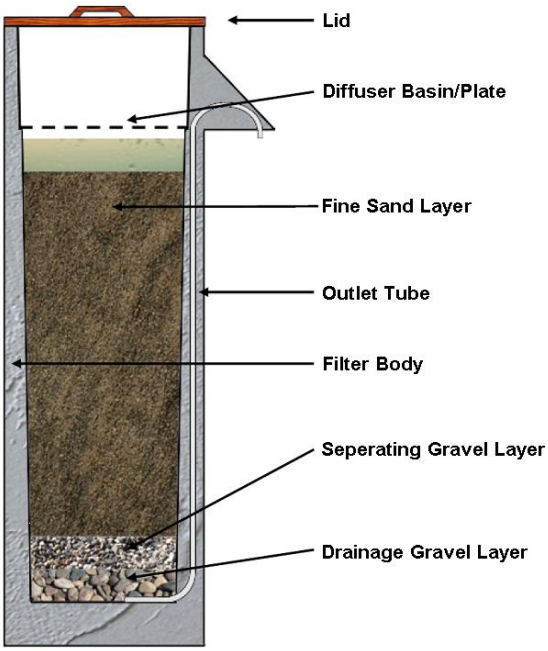


Figure 10: Cross section of a concrete shell biosand filter. (SSWM 2009)

LifeStraw® is a personal and mobile water purification tool, which is a hand held plastic cylinder 22,5 cm long. The company itself states its beginnings to originate from parent company Vestergaard in 1994. Vestergaard was tasked with developing a filter, which could remove Guinea worm larvae from contaminated water. Original filter was a cloth type filter, but in 1999 the invention evolved into the more effective pipe form. Lifestraw claims that over 37 million of such filter have been part of nearly complete eradication of the Guinea worm disease. (Lifestraw 2015) LifeStraw® itself was released in 2005 and it has since been used in multiple disasters, like in the 2010 at the Haiti earthquake and floods of Pakistan. The Lifestraw® is easily portable at a weight of 56 grams and it is capable of purifying a minimum of 1000 liters. Furthermore it is chemical free and doesn't need any external energy sources, apart from the person sucking at the straw. The purification works by using a hollow fibers as its microfiltration technology and is deemed to remove 99.9999% of all bacteria and 99.9% of protozoan parasites, including giardia. The straw filters particles larger than 0.2 micrometers. That is 200 nanometers. (Vestergaard 2015) The product can be found online at a price of around 20 dollars US. This calculates into $0.02 per liter.

SlingShot was created by Dean Kamen and it was aimed to provide 1000 liters of pure water per day, while using less than 1kW of power doing so. The system is powered electricity from wall socket, a diesel generator or even by a Stirling engine running on any combustible fuel that creates

heat. This stirling engine has also a magnetic rotor inside a metal coil, which is turned by the moving pistons. One of the Kamen's stirling engines produces 1 kW, enough to run an additional water purifier or energy-efficient lights in a small village. Operating principle of the SlingShot is vapor-compression distillation, and therefore it requires no filters. One of the original goals of Mr. Kamen was that the system could run 5 years without overhauling or maintaining. This solution makes it capable to process even sewage. With the access of an energy source, utilized by the stirling engine, the contaminated water is pumped in via a tube, after which it is warmed to 100 degrees Celsius. The hot water is then moved into the evaporator, where its temperature is raised even more to boil into steam. All extra matter left by boiling can be drained out. The steam is already free of bacteria, viruses and spores, which are pasteurized in the purifier heat. The steam rises up and is guided into the compressor. The increase of pressure in the compressor makes the steam a little bit hotter than 100 Celsius. This steam then flows into an outer chamber, where another phase of filtering happens. The outer chamber walls are about 100 degrees Celsius, which causes water to condense on the walls. Contaminants like benzene, which boils at less than 100 Celsius is vented out. Clean but hot water drips into the last chamber, from where the outgoing water is directed alongside the incoming water. This cools down the outgoing water and heats up the incoming water, saving energy that is needed to heat it up. The issue with the SlingShot is the difficulty of affordable mass production of the stirling engines. (HowStuffWorks 2015) Calculating cost for SlingShot, with one estimated cost of 2000 dollars US, comes roughly to a mere 0,1 cent per liter (see equation). Equation below assumes that the SlingShot would only survive the first 5 years and that combustible the fuel has been free. Cost of water per liter will naturally increase when fuel costs are added.

$$\frac{2000\ \$}{5y * 365d * 1000\frac{liters}{day}} = 0{,}001096\ \frac{\$}{liter}$$

LIFESAVER Jerrycan®, as well as other Lifesaver products, employs an advanced ultra-filtration to filter the contaminated water. The jerrycan version of their product is simply a jerrycan shaped container with an integrated filtering cartridge, and two external access points instead of the usual one. One for water coming in, one for the filter to spout clean water from. Cartridges for the LIFESAVER jerrycan® are rated for 10 000 liters and 20 000 liters. With the larger capacity cartridge it is available online at a price of around $314 (Amazon), which makes the price for each liter is roughly one and a half cents ($0,0157). The pathogen retention of this product is done by

15 nanometers holes in the filter, which makes it rated at 99.999995% for bacteria and the virus retention is claimed to be 99.999%. Though at the present an independent laboratory tests based on a NSF Protocol 231 have found the virus removal testing to not be as efficient as claimed. Results showed that the virus removal was done only at 99.9% retention level, while the EPA guideline for virus removal is 99.99%. LIFESAVER has issued a "cease dispatch" order due to this result. (LIFESAVER 2007)

Watercone® and **Solarball** are compact solar stills that have a clear cone- or ball- shaped tops and a black bottom pan. They rely on the SODIS principle for distilling contaminated water by collecting the condensed vapor. Therefore the Watercone and Solarball are capable of processing even seawater or brackish water. These devices are rated to produce up to 1.7 liters and 3 liters respectively of clean water per day. This can be considered as a quite a small amount, which would necessitate several devices to be used in unison. Their operation as a SODIS devices is extremely simple and requires very little instructions for use. This simplicity is a key feature that appeals to the target demographic in developing countries. The efficiency of both the Watercone and Solarball is not high, but the designs have gotten attention and even awards. It is a great proof of concept for what simple SODIS devices could achieve. (Watercone 2002; Earthtechling.com 2011; Heinbuch 2011)

Pressurized recharge wells are a recent addition to solving the water issue, which causes social problems in rural communities, in particular rural schools in water-scarce regions of India. According to one estimation India has 80 000 square miles, which is 207 000 square kilometers, of brackish water. That is an area roughly the size of whole Great Britain, which has too high salt content for drinking as its groundwater. In India the civil engineers from the Sehgal Foundation have come up with a clever solution in the form of pressurized recharge wells for gathering fresh rainwater. The principle is to collect a pocket of freshwater into the existing saline groundwater (Figure 11) using hydrostatic pressure. Tall well cylinder is needed to create this pressure, and the bottom of the cylinder has to reach below the surface of the saline groundwater or otherwise the pocket will not form. Previous recharge wells have gathered the collected freshwater as a layer that sets on top of the saline groundwater. This layer will spread thinly and will be difficult to extract for usage. The created pocket of fresh water does not mix with the more concentrated saline groundwater, and can be pumped up with a hand pump. Possible contaminants can later be purified by pairing the system with a Biosand filter, which then can fill a water tank full of only purified water as seen in the Figure 11. (Sehgal Foundation 2014; Sehgal Foundation 2001; Lufkin 2015)

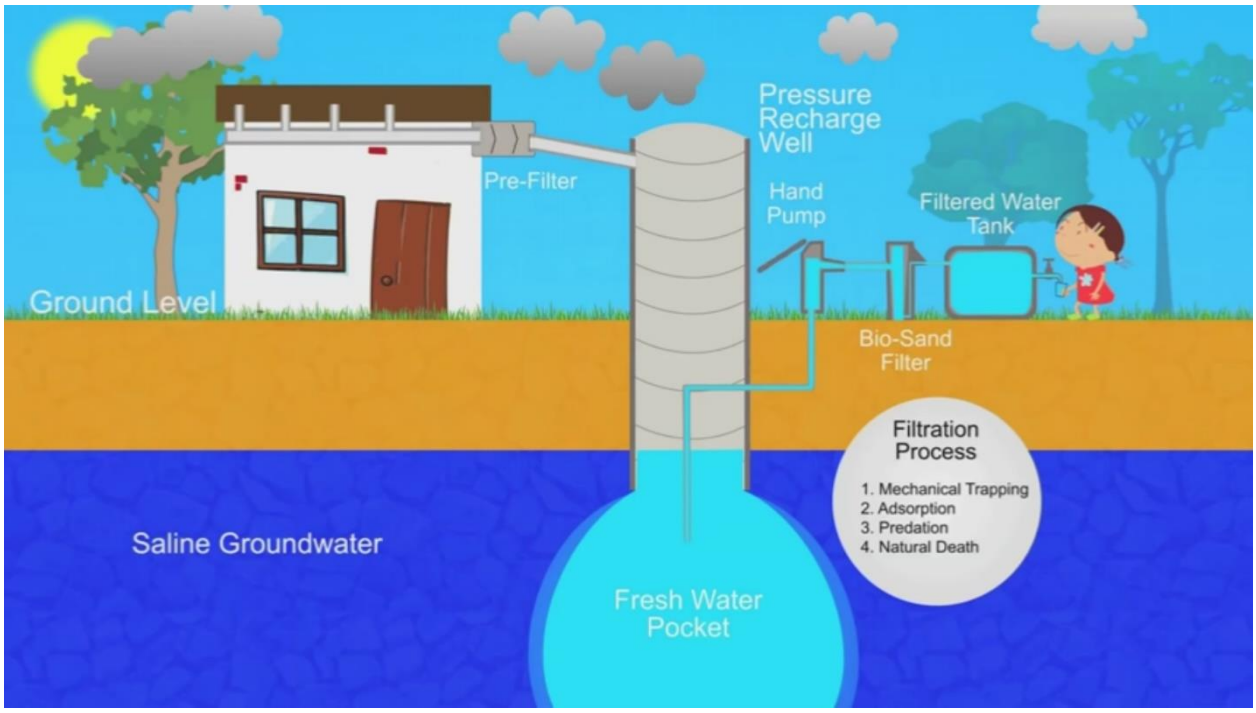


Figure 11: Diagram of the working principle of pressurized recharge well. (Sehgal Foundation 2001)

Ceramic filters function in the same principle as any membrane filter. The ceramic pots, made from fired clay, are porous and can thus filter water. Pore sizes of these pots can be as small as 0.2 micrometers, which is small enough to remove almost all bacteria and protozoa. This sets ceramic filtering as a "microfiltration" process. The filtration is operated by gravity and does not necessitate any high-tech methods for pressurization. The flow rate for these ceramic pots is estimated at 1 to 3 liters per hour. Some minor maintenance is required to keep the flow rate of a filtering pot high. The build-up of excess material on the surface of the filter can be prevented by regular cleaning. This scrubbing will eventually erode the surface of the filter, but the ceramic pots are relatively inexpensive. Depending on the local economy, these filtering pots can be produced by the local private sector from around 5 to 25 dollars US. The benefits of this type of filter is well recorded in Cambodia, where diarrhea cases were reduced to half of its original rate of occurrence. This statistic is in despite of some mishandling of the filters, which has caused the ceramic pot to crack. A cracked pot will not of course have a consistent small pore size to filter all the bacteria and protozoa needed, leading to higher incidents of diarrhea. The history of the ceramic pot filter dates back to the antiquity, so it cannot be called a new idea. Nevertheless the process is still a very viable solution for water filtration with the following advantages:

- Locally producible
- Lightweight
- Portable

- Inexpensive
- Chemical free
- Low-maintenance
- Effective
- Easy to use

(Brown and Jobsey 2007)

Calculated estimation of the running costs per purified liter of water vary depending on the original building price. If the original complete system (Figure 12) is assumed to be 10 US$, and the capacity of a pot is 25 liters per day, a system with an average longevity of 1 year calculates to 0.0011 US$ per liter. Subsequent years will be significantly cheaper at 0.00027 US$ per liter, as only the ceramic pot is needed to be replaced. This makes ceramic pot filters very competitive solutions in countries of extreme poverty. (Brown and Jobsey 2007) In fact it has become even a symbol of poverty as a result of its cheap cost, which has caused problems and a need to design a "luxury" version of the same ceramic filter. The first investment can nonetheless be too high for the extremely poor, if they do not have external financial aid. (Vousvouras and Heierli 2010)

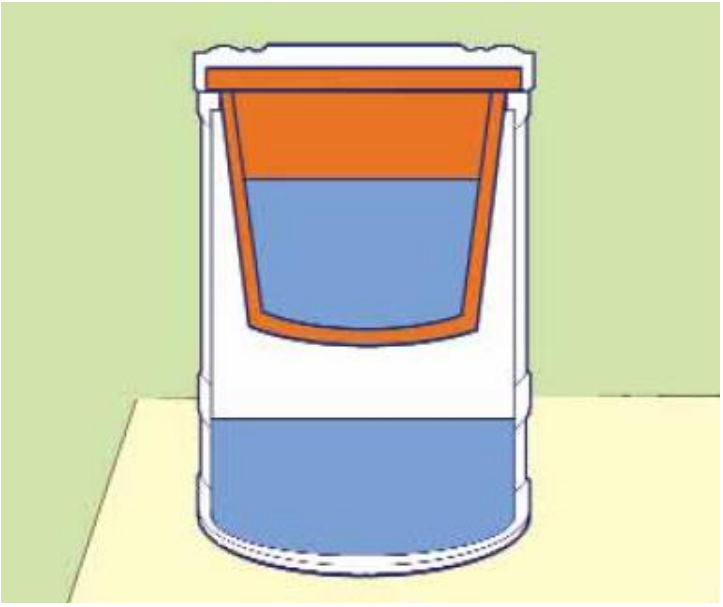


Figure 12: Ceramic filter shown in orange, fitted inside its receiving container. (Brown and Jobsey 2007)

Chemical purifiers are common means of making sure the drinking water is free of contaminants. Purifiers Aquasure and Pureit together cover 20% of sold water purifiers. Their popularity has improved mainly due to their effectiveness and affordability for the middle to higher wealth level of developing countries. Reports suggest that both of the mentioned brands are growing 100% per year, which is partly due to their simplicity and that they require no electricity. This especially makes them ideal for remote locations with no electricity or unpredictable power supply. Basic

working principle is the use of a chemical, commonly chlorine, to add into the water to decontaminate pollutants. As products they are often simple products, like tablets, but commonly leave a chemical taste to the water it was used on. (Project Jal 2011; Vousvouras and Heierli 2010)

Aquasure has a relatively high cost of 0.13 US$ per 20 liters of daily water per person. This number comes from the 7000 US$ set-up cost of the chlorination/coagulation plant. The estimation is that the investment would pay itself back in two years, if it had 230 families as regular customers. Some of the poorest countries can struggle to afford this and also the investment cost of 7000 US$ for the plant can cause problems in Africa, where the credit market is underdeveloped and such loan might be difficult to acquire. (Vousvouras and Heierli 2010)

Pureit is a purifier that was launched in 2005 by Unilever Hindustan. Pureit has a four-stage filtration system. Firstly all the coarse dirt is filtered by a microfiber mesh, followed by a carbon trap to remove parasites. This is followed by a chlorine tablet, which classifies it as chemical purifier, to kill viruses and bacteria from the water. Last stage is a "polisher" that improves the taste of the water so it is more palatable to drink. Pureit is estimated to already be in three million households. Much of this success is in the big cities of India. The entry level price for Pureit is 35 US$, which makes it too expensive for the extremely poor who live on less than a single dollar per day. Unilever has also responded to more affordable competition with a 20 US$ lightweight model. It owes much of its success to the existing Unilever distribution network. Unilever has also expressed interest in the lower income demographic as the urban upper level BoP markets have become more saturated and less profitable. (Vousvouras and Heierli 2010)

Aqualite™ System is a high volume filter produced by JOSAB, which is recommended to be combined with UV disinfection. The system needs electricity to operate and the amount of power needed depends on the model (Table 5). It is claimed to be ecological and portable due to its container like end units, which are easy to ship. Though here portability is relative, since it is not actually a personal filtration device. The volume of purified water is far beyond the other technologies we have listed so far. Therefore the Aqualite™ System is more suited as a dedicated water purifier for a whole village or even a town. Filtering volumes depend on the product model (Table 5) and range between 10 and 3000 cubic meters of purified water per 23 h production day. The application of this system also requires a daily backwashing to clean the system. As a result it demands clean water for its own washing. (JOSAB 1998)

Table 5: JOSAB's product range of AqualiteTM systems with listed size, water production and required power. (JOSAB 1998)

STANDARD PRODUCT RANGE

Model	Container size in feet*	Production m³/day**	Power kWh***	Power use in watt per produced liter of save potable water
SC2700	45	1800 - 3000	36	0,28 - 0,47
SC1800	40	1200 - 2000	24	0,29 - 0,47
SC900	20	600 - 1000	13	0,29 - 0,49
SC500	20	400 - 650	12	0,46 - 0,75
SC100	20	100 - 170	3,5	0,41 - 0,69
P100	Pallets	78 - 130	2,5	0,46 - 0,76
P25	Pallets	20 - 33	0,8	0,58 - 0,96
PortableBasic	Wheels	14 - 24	0,8	0,88 - 1,37
PortablePro	Wheels	10 - 15	0,6	0,96 - 1,44

* ISO class sea high cube container. Size based on standard installation. Additional add-ons can give a larger or separate container.
**based on 23 hours production per day and 1 hour per day backwashing.
***For a standard unit

The filtering medium for Aqualite^{TM} systems is a non-chemical clinoptilolite. JOSAB states on its website that clinoptilolite is "a natural zeolite with exceptional adsorption capacity" and that it is mined in northern Hungary. Its pore structure is uniform and the pore volume is large, if the manufacturer is to be trusted. JOSAB states the pore diameter to be from 0.1 to 1.0 nanometers and that it would filter out particles larger than one micron. The filter itself is said to filter 98% of all bacteria and parasites. In addition it filters heavy metals ammonium and hydrogen compounds, as well as adsorbs chemical and petroleum compounds. The efficiency can be improved by adding a UV light to purify the water completely of heterotrophs, coliforms, E. coli bacteria, Giardia lamblia and Cryptosporidium. General function of this Aqualite^{TM} system can be seen in Figure 13. (JOSAB 1998)

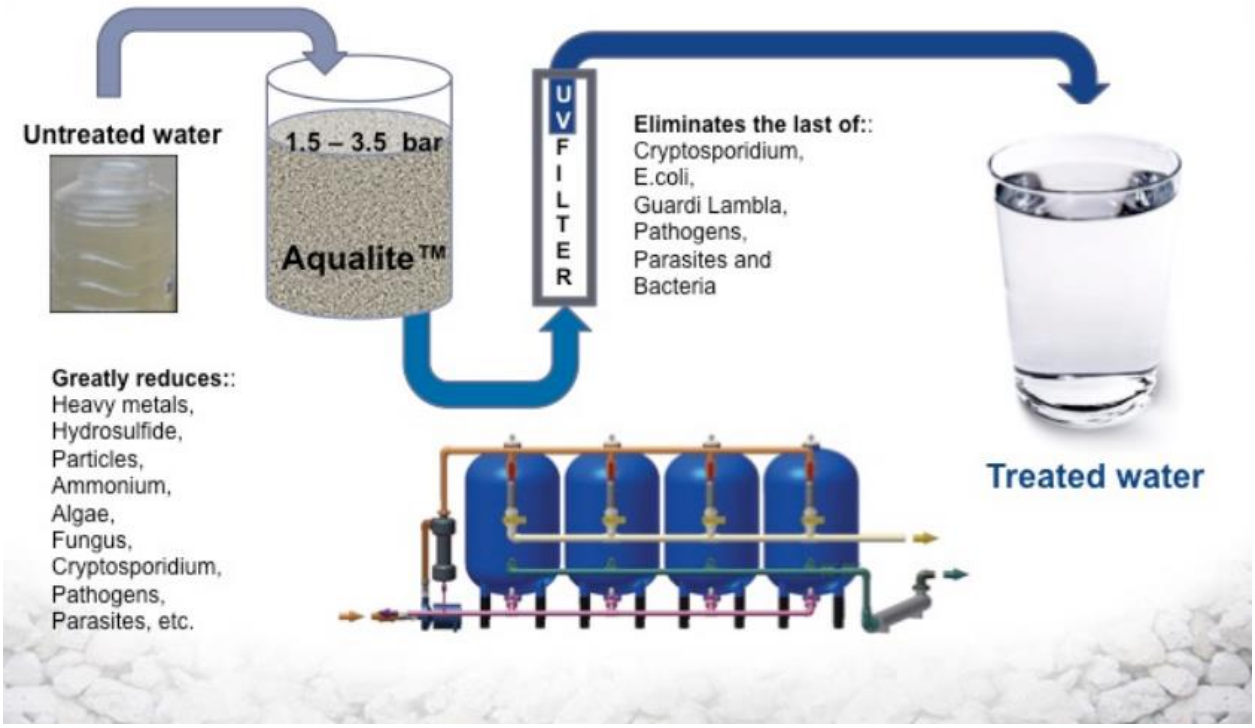


Figure 13: The working principle of JOSAB's AqualiteTM System. (JOSAB 1998)

When considering what technologies and products of water purification one should start bringing towards a certain BoP market, an assessment has to be made to see how plausible is the success of that solution in the scheme of the local economy. In addition to financial issues, the possible maintenance issues play a factor towards the product being of too high-maintenance for the population use. In Table 6 we can find examples of certain filter solutions, which represent their type of method when we consider their plausibility and utilization success. We can see among the previously introduced products inside the table one added filter technology. KX World Filter is a nanofiber filter that has high filtration volume of 2000 gallons of water a day (7570 liters) in its scaled up model, which is aimed at whole villages (Hammond et al. 2007).

Table 6: Compiled unit prices and cost of purified water per liter for most of the previously introduced products. ([1 = Price per liter deducted from initial price; [2 = Estimate for Biosand filter with concrete shell; [3 = Cost per liter for 2 year service life with 230 families consuming 20 liters per person; [4 = Calculated with an estimated 7 year life expectancy)

Product	Price per unit	Cost per liter
Biosand filter	$12-50[2	$0
LifeStraw®	$20	$0.02[1

SlingShot	$2000	$0.0011(1
LIFESAVER jerrycan	$314	$0.0157(1
Aquasure	$7000	$0.0065(3
Pureit	$20	unknown
Ceramic filter	$10	$0.0011-0.00027
Watercone	$25	$0.01(4
KX World Filter (village)	$150	$0.00026

Talking about solutions in household water treatment and safe storage (HWTS) in developing countries we have to highlight the most spread in use practices as filtering, boiling and chemical disinfection of water. These measures are proven to be effective in improving the microbiological quality of water meant for drinking (Clasen 2015). In addition, concentrating on the point of use, HWTS is able to reduce risks associated with recontamination of water during delivery from improved water sources (Wright et al. 2003). In spite of the fact that HWTS has been applied for decades, active use and promotion of household water treatment and safe storage has increased significantly to this day as a population health intervention strategy. Although the HWTS practices cannot be considered as blindly reliable in comprehensive purification of drinking water, they are the most affordable by poor and can be used while developing world is anticipating technological progress in purification water technologies. (Clasen 2015)

2.2.1 Clean water technologies for the poor in relation to sustainable development

Advancement in mechanisms which address essential needs of humanity, while implementing development processes in harmony with the nature in a way that doesn’t result in irreversible loss of resources in any of involved parties, refers to the concept of sustainable development.

The notion of sustainable development originated in the far 1987 with the definition "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" in the World Commission on Environment and Development’s report (UN General Assembly 1987). What is rather important, the next two key concepts of the suggested definition were highlighted:

> - the concept of 'needs', in particular the essential needs of the world's poor, to which overriding priority should be given; and
>
> - the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs.

One of the major difficulties in utilizing the term of sustainable development is to attain equilibrium among social, economic and environmental requirements.

To illustrate the complexity of sustainable development let's cite a plain example.

> What happens to the environment in the long term if a large number of people cannot afford to meet their basic household needs today? If you did not have access to safe water, and therefore needed wood to boil drinking water so that you and your children would not get sick, would you worry about causing deforestation? (Sustainable Development Information [no date])

That large amount of people refers to an existing over two billions of citizens in developing nations. And their survival issue is described literally. Often they have no other choices but trying to purify a filthy water with boiling, using up wood supplies, which after a time, turns against sustainability paradigm. To not let the situation come to a critical point, water purification technologies must be brought into use in the developed world.

During a few decades over a hundred of other definitions of the sustainable development appeared. To become explicit for comprehending, the term and its implications have had to be thoroughly discussed in academic communities and trialed in actual implementations for decades. Nowadays in the light of unprecedented and alarming environmental problems across the globe together with thousand millions of unserved people with basic needs, sustainable development becomes as relevant as never before.

When talking about global sustainable development, it is necessary to admit that first and foremost, survival needs of the poorest and most vulnerable ones in developing parts of the world must be addressed. With regard to over a billion human lives with lack for access to safe drinking water, international sustainable development might seem quite challenging. However, while the majority of the world's population may possess surpluses of not only material resources but scientific, technological and other attributes of replete life, this shameful disparity must be eliminated. As a speaker from WCED Public Hearing expressed the idea:" You talk very little about life, you talk too much about survival. It is very important to remember that when the possibilities for life are over, the possibilities for survival start" (UN General Assembly 1987), among our moral obligations we all ought to include careful consideration of those who might be affected by our own choices, the world's poor, who struggle to survive in extreme conditions, while developed

world may squander and waste more resources than might be just enough for whole communities of poor to live on.

Thus, it is in our power to share the knowledge and the technology to ease the burden of severe third world conditions. Environmentally oriented clean water technologies are some of the prime tools in the course of meeting the essential needs sustainably. Moreover, in relation to the importance of delivering water to uncivilized populations, technology transfer should be incorporated as a unit of water program targets.

In the first place, water supply and sanitation services, including water as a resource, are crucial to sustainable development. It is worth noting also, that so-called social sustainability depends heavily on the adequate access to these services (Ogujiuba, Stiegler and Fadila 2012). In the second place, in order to provide adequate water supply and sanitation sustainably, application of clean water technologies is imperative. As the case stands, without relating to clean water technologies in the provision of water and sanitation, it would be practically unfeasible to implement environmental protection, ensure food security, to cope with productivity losses due to malnutrition, diseases and high death rate, to solve gender disparities, and simply to increase tourism and investment flows. Hence, "increasing access to domestic water supply and sanitation services and improving water resources management are catalytic entry points for efforts to help developing countries fight poverty and hunger, safeguard human health, reduce child mortality, promote gender equality, and manage and protect natural resources", declares task force on water and sanitation coordinators of the UN Millennium Project. (Lenton, Wright and Lewis 2005) Similarly, OECD's perspective on investing in water and sanitation projects involves affirmation of wastewater treatment interventions as the most advantageous towards improving public well-being, environment and certain economic sectors. (OECD 2011) Following this, it is easy to conclude that clean water technologies play one of the major roles in the course of sustainable development.

In developing nations economic development as integral part of sustainable development cannot be proceeded without taking environmental concerns into account. Deteriorated environment has large number of detrimental impacts on health, food security, education and job opportunities, and gender equality, which in turn places binding constraints on economic development. Unable to meet elementary needs in water and sanitation an individual simply misses his chances to study or work properly, because the probability of getting ill from contaminated water and unhygienic

conditions is too high. That is why investing in the environmental sustainability should be prior to the investments in any other sphere, especially in developing countries, where mere survival of people might become a critical impediment to social and economic development. Obviously, the strategies of the recently established SDG should be formed and applied in an environmentally sustainable manner right from the beginning. (Sachs 2005)

Ogujiuba, Stiegler and Fadila (2012) mention the fact that sustainable development implicates stability in the resource base, which consists in averting complete reduction or exhaustion of non-renewable resource and preventing excessive extraction of renewable one. Use of clean water solutions, for example, offers such possibility to meet that stability with respect to precious water resource.

In the General Assembly resolution 66/288 the reference to sustainability in the vision on water and sanitation is clearly provided: "We recognize that water is at the core of sustainable development as it is closely linked to a number of key global challenges. We therefore reiterate the importance of integrating water into sustainable development, and underline the critical importance of water and sanitation within the three dimensions of sustainable development." (UN General Assembly 2012)

If an organization strives to make business in a developing nation, its projects have to conform fully to the sustainability issues. In accordance with Prahald (2002), companies should be very mindful of instituting technological innovations in the BoP sector and they would not have any other choice but to avoid the environmental mistakes made by developed world during last semi centennial period of time. Modern global MNCs were born at the time of reckless nature exploitation and have been thriving over a time plentiful of natural resources, but nowadays in the experience with developing nations business makers do not have that privilege anymore, to create products and services which made in unsustainable way and result in deeper resources depletion. The consumption patterns should be thoroughly reevaluated.

What counts here is that taking care about sustainability issues in the environmental aspect, actually, increases efficiency of the existing in a company business models, simultaneously lowering both expenditures and risks. Hence, we can safely assume that offering water treatment technologies to the poor, companies should consider eco-efficiency as the role model for their own good. As for the corporate social responsibility (CSR), it should involve corporate philanthropy, volunteerism and simple care about the "under the hatches" ones. Besides, CSR practices acquire a good share of reputation for a company. (Mahajan 2013)

Owing to the fact that at the present time water management authorities of developing nations struggle to supply populations with adequate water services due to avalanche geographic increase and urbanization together with incremental water shortage, the literature suggests alternative water provision technics and practices, which above all are commonly sustainable in comparison to big scale conservative engineering approaches. Among such alternatives there are substitutions to large scale traditional infrastructure (pipelines, dams or aqueducts), and alternatives to complex centralized waste water treatment. (Makropoulos and Butler 2010; Srinivasan et al. 2010; Otterpohl et al. 2003; Larsen et al. 2009; Butler and Parkinson 1997; Larsen et al. 2001) Moreover, in spite of the fact that currently used in developing communities water treatment systems contribute into positive changes in morbidity rates and bring other benefits to people, it has been alleged that some of their environmental, economic and even social impacts appear to be negative. (Gleick 2003) To oppose this issue and to allow sustainable development to be the course, mentioned alternatives should be taken into close consideration by decision-makers. Gleick (2003) believes that in order to manage with unsolved water problems in developing countries previously used options should be abandoned as insufficient and already existing systems should be supplemented with the low-cost community scale-systems, decentralized options, efficient and environmentally friendly technologies. (Gleick 2003, Starkl and Brunner 2004) That is the right way to sustainable development.

To draw an analogy with the distribution problem of electric energy generally, cited by the Hart and Christensen (2002), we may meditate upon a similar issue in the water resource distribution, particularly in developing world. The problem lies in the lack or absence of water infrastructure in numerous both rural and urban areas of developing regions, though the issue is more prevalent for rural populations. As opposed to the affluent countries with its broad centralized facilities and large pipe-networks for efficient water distribution, low-income populations cannot afford such comfort, at least not nowadays. However, reasoning in terms of sustainable development we shell admit that various point-of-use water supply and treatment systems appear to be more affordable for the poor households and, what is important, environmentally sustainable. Avoiding the necessity of creating expensive distribution infrastructure, especially in rural areas as well as eluding high municipal pipe leakage rates, communities can directly apply point-of-use systems to generate essential amounts of clean water, as well as avert environmental impacts. Hart and Christensen (2002) call this approach ‘distributed generation’, which is included in the disruptive innovations principles and works to the best advantage in the emerging markets.

Summing it up, in relation to sustainable development various decentralized and point-of-use affordable and environmentally friendly clean water technologies exist for the poor as alternative solutions to costly and often unsustainable centralized physical infrastructure and traditional large-scale systems.

2.2.2 Possible solutions, actors and factors affecting the development and market of clean water technology in the BoP

The BoP people all together represent the biggest category of potential participants in the consumer market. Despite their low individual incomes, the group of few billion persons, which is about half of the global population, have an ability to have a collective impact on the market by having substantial purchasing power. Both this power and distinct behavior of the poor people as consumers offer considerable perspective for market-based approaches to give chance for fulfilling the potential of these people, while at the same time answering their needs and improving their economic situation (World Resources Institute 2007). In other words, this is the way of following the whole idea of the shared value creation in the BoP approach proposition. The proposal of BoP business strategy implies a combined shared benefit for commercial and social sides. Social side is the poor who obtain development opportunities, and commercial side represents enterprises which deal with BoP sector while having profit from it on the one hand and giving those development opportunities to poor on the other hand. Meanwhile, to let the synergy between two sides thrive, the BoP population should play its role: the poor should endorse enterprises by sharing their knowledge and experiences which might become sources of project ideas and innovations for businesses. Also, it is very important to understand expectations of BoP individuals for creating appropriate solutions and business models (Le Guen 2012). Both sides have to collaborate in co-creation of shared value. One of the authors of the BoP concept himself, Stuart Hart, in his interview with Mahajan (2013) underscores the importance of co-creation, because almost the only possible way to contribute to a value proposition is engaging individuals of the community in the process. He also points out 2 reasons for the necessity to involve locals into the business. Firstly, organizers cannot know for sure what actions would be the best to implement in terms of a targeted product, which is going to be marketed, and secondly, people engaging approach is the best method to create a wider value proposition. For example, one of the co-creation approaches described by speaker Mansour Fall in Le Guen's report (2012) intends to integrate the two actors in the inventive process of creating mutually beneficial products and business models, and obviously it goes above

plain consulting of stakeholders. One of the crucial periods of collaboration is diagnostic phase, which might be a long drawn out process and be inconvenient from time to time. However, actual impact expressed in created actions, demands this necessary phase. Another speaker Arnaud Druet pays attention to how companies should place themselves in the position of integrators while involving in all the other phases such as designing a service or a product, its marketing and promotion. Such positioning gives an opportunity to define a framework of a service which will embrace comprehensively the essential demand, while accepting faults and focusing on possible obstacles. The role of integration skills, which are essential for entering the market, could not be overestimated. A company should be able to learn quickly from scarce experiences and mistakes of other enterprises, and be able to bring together professionals of different kinds such as designers, engineers and sociologists who might not be used to collaborate all together with policy-makers, governments and organizations themselves. In the same report orator Asif U. Ahmed mentions potentiality to hand with middlemen in the business-making process to ease communication between company and a stakeholder. To understand hindrances to co-creating speaker Guillaume Thureau puts forward three the most important factors which negatively impact success: "firstly, the reflex tendency to continue with business as usual; secondly, the desire to act on all fronts, something which can prevent the business from outlining and prioritizing its social objectives; thirdly, the false idea that models that work in one part of the world can be transposed anywhere else". (Le Guen 2012)

Prahalad and Hart (2002) claim that cardinal innovations in business models and technology are obligatory for creating business between MNCs and impoverished of the BoP category. Products and services offered by the organizations to the poor must be reevaluated from the price-performance point of view which "will demand a new level of capital efficiency and new ways of measuring financial success", Prahalad and Hart wrote in their paper. The most prosperous companies in the world are challenged to raise living standards of the poor by producing and distributing services and products in environmentally sustainable, culturally sensitive and economically profitable ways.

World's corporate sector is missing vast market opportunities along the largely extensive segment of the BoP population, because the amount of offered products and services and their quality are not high. However, what is fortunate, the same market is broadly open for technological innovation, and the clear advantage in this area is a unique opportunity to omit many kinds of environmental mistakes made by developed countries on the way of their growth. (Prahald and Hart 2002)

In a contradiction with orthodox assumption about the poor being unprofitable consumers in the business, Prahalad and Hart (2002) prove in theory the opposite, accenting that MNCs should adjust their business models and be content with low margins, meanwhile financial gains will be induced by volume and capital efficiency.

Undoubtedly, unexperienced and unorganized, almost virgin BoP sector may occur as one of the most dangerous places for entrepreneurs to have business in. Rangan, Chu and Petkoski (2011) call this sector a 'world of pitfalls', where focusing solely on the commercial gain is out of the question. But even if a company firmly attends to the needs of the poor, while keeping profits as secondary aim, it doesn't become less risky to cope with unexpectedness of unconventional BoP market. Moreover, if a firm doesn't comprehend the specifics and features of the BoP market and cannot figure out the ways to make an adequate revenue outcomes, it should not cherish the hope for its survival in the market. In particular, failed experiences of some companies illustrate that dealing with poor, one should not keep the scale of the business operations small, because of high likelihood of weak profits, and therefore inability to fulfil the social value. For instance, one the promising Procter & Gamble's water-purification products in Asia and Latin America could not come through with its project due to inability to manage with the low-margin environment and to find a profitable distribution strategy and price. So, as a result, the company's commercial initiative was absorbed into its CSR efforts. (Rangan, Chu and Petkoski 2011)

Rangan, Chu and Petkoski (2011) show the ways to overcome the hardship of the BoP market. It is advised for companies to link their financial success with the empowering of those who they work with. Talking about creating best strategies of value-creation at the BoP, researches have made a clear point of the importance to segment BoP market into a number of precisely defined categories, which are:

> *Low Income:* $3–$5 a day, 1.4 billion people
> *Subsistence:* $1–$3 a day, 1.6 billion people
> *Extreme Poverty:* Below $1 a day, 1 billion people

Authors discuss four value-creation strategies for the BoP application, indicating for them the 'sweet spots' from the mentioned categories of different living standards. Such as, under the circumstances of low income segment an approach of "providing appropriate and affordable products and services directly to consumers" will fit as the most effective. For the subsistence segment two of the strategies are offered: "enlisting individuals or small businesses to provide efficient reach and coverage" and "engaging the community to coproduce value – for example, in

the supply chain", and lastly, extreme poverty is a 'sweet spot' for the "forming commercial partnership with governments and NGOs" strategy. (Rangan, Chu and Petkoski 2011)

In delivering basic service such as clean water, special attention should be referred to the extreme-poverty segment of the BoP market, because it is the very category of the poorest which seem hardest to have business with, however, that 1 billion of people need it the most.
However, it is hard to deny that attempts to serve bottom billion domain would seem as a pure aid from the business point of view, and targeting solely the extreme poverty segment would be pretty tough, remarks Stuart Hart in an interview (Mahajan 2013). However, that is why heavy investments should be done first of all in this BoP segment, while companies have to engage into public-private partnerships in order to obtain subsidies, market exclusivity and cost recovery guaranties. To give an excellent example of private and public value intersection, Rangan, Chu and Petkoski (2011) describe a case which happened in eastern Manila, Philippines more than twenty years ago. At that time poor population has been paying six times the municipal rates to purchase their water in metal jerry cans from street dealers who has been withdrawing water against the law from the municipal water network. In 1997, a private syndicate called Manila Water was granted an opportunity to influence such disparity by arranging the fair water provision. Collaborating with local communities, public authorities and contractors, the firm was able to gain public trust while providing access to inexpensive water of adequate quality. The execution of the project required more than a billion dollars of investments and exclusivity rights from government as well as other guarantees. As the result, during past ten years Manila Philippines has been returning over 15% on invested capital each year. Visually the case in represented in the following Figure (14).

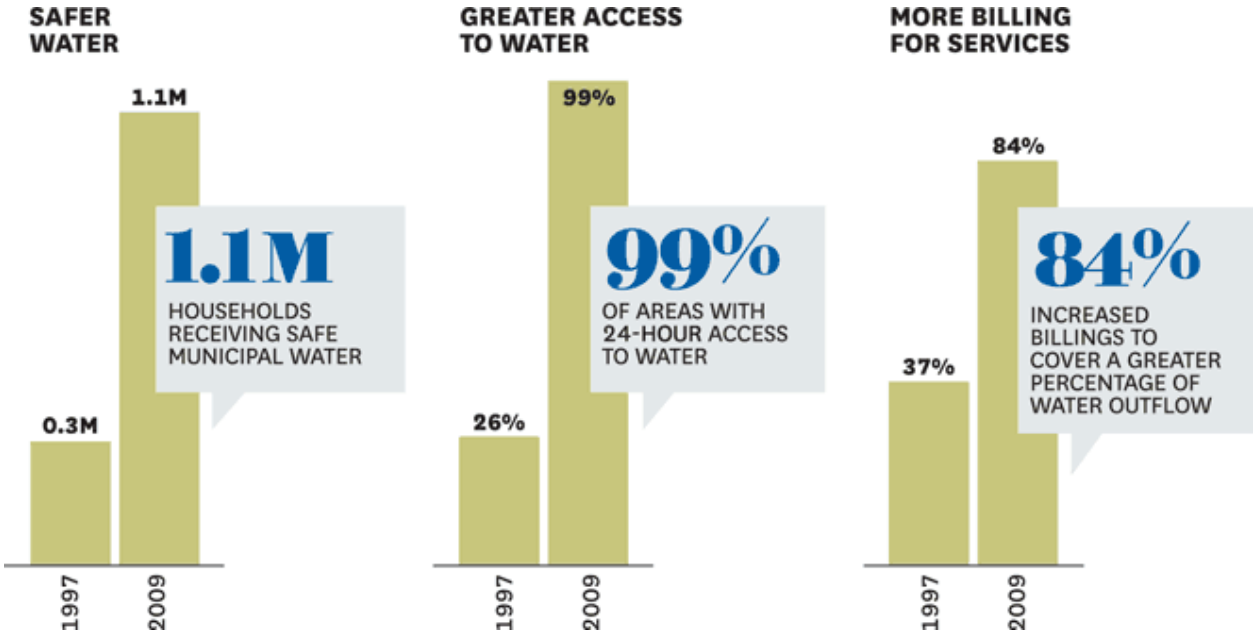


Figure 14: Visual representation of the Manila case, 1997 – 2009 projections. (Rangan, Chu and Petkoski 2011)

A great example of creating shared value in the BoP market has been shown by the global health organization PSI, which specializes in developing markets for health promoting services and products, including water, sanitation and hygiene, and makes sure that they are delivered and used by low-income consumers, especially by those who have less ability to pay. PSI's water, sanitation and hygiene (WASH) programs are well-known in the world. For instance, PSI is the largest distributor of safe water solutions across the world. Spread in markets of developing countries, water products and solutions are being manufactured locally, providing business and jobs for the private sector, while decreasing production costs as well as increasing sustainability of projects. PSI is not an ordinary NGO. While seeking no profit in helping the most vulnerable in developing countries, it takes a business approach in saving lives and uses social marketing and franchising as its tools. The communication initiatives in every served region are managed by local teams which collaborate with a number of partners, such as international organizations, community-based organizations and national and local experts and officials. PSI also cooperates with the public sector, such as international donors, policy makers and in-country governments. PSI claims that, measuring their positive impact, it estimates effect on disease burden and death rate much like a company measures profit. (PSI 2015)

Another worthy of notice examples were shown by an Indian private companies WaterHealth International (WHI) and Heritage Livelihood Services in concert with the Hyderabad Metropolitan Water Supply and Sewerage Board. WHI has developed a line of affordable UV water disinfection products viable in various scales and succeed to localize value creation in a village where no one

has been paying for water in the past due to absence of inexpensive safe water options. Other company has managed to serve clean water in peri-urban areas of a city by well thought-out investments at a considerably lower costs compared to other providers, nevertheless all expenditures were managed to be covered. In addition, the company has induced community elders to carry out educational programs concerning water delivery improvement. These companies in collaboration with government and operating with private and public funding were able to execute strategy on focusing on the BoP. These enterprises hold good examples how it is possible for private companies to have business with the poor and at the same time cooperate with the public institutions. (Hammond et al. 2007)

Mentioned above examples are one of the proofs of the fact that there are, indeed, opportunities for successful business at the BoP sector. Vousvouras and Heierli (2010) insist on the plausibility of this fact saying following. Low-income customers, with earnings below USD 3000 a year, account on average for 45-60% of the total revenues of the water markets in Asia, Africa, Latin America and Eastern Europe (see Figure 15). Together they constitute a worldwide sales amount of USD 20.1 billion, which by no doubt implies that there are good business prospects at the BoP water sector.

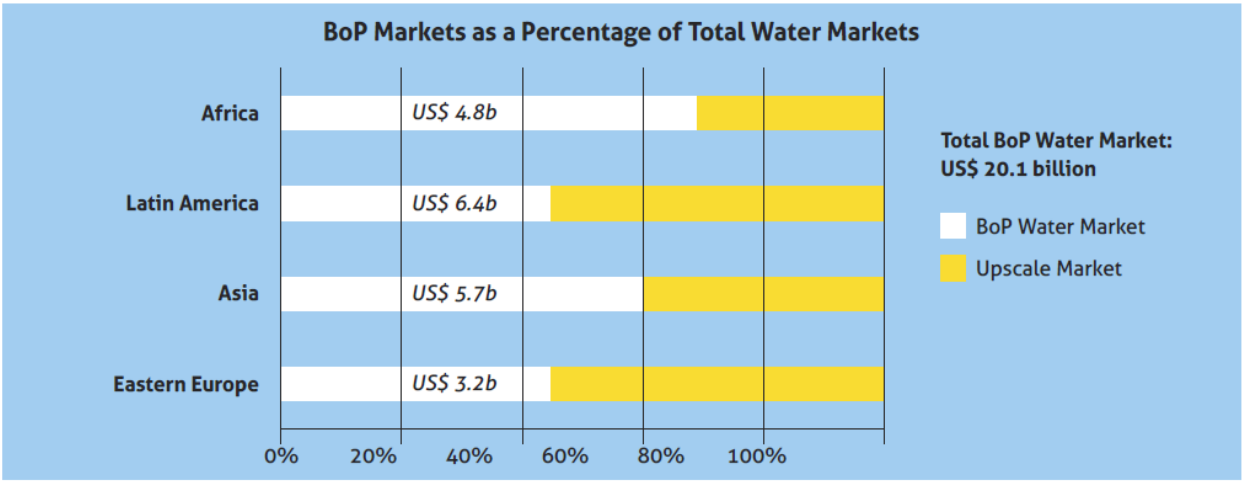


Figure 15: Sales figures of water markets in the developing world (Hammond et al., 2007, p. 9; pp. 52–59, cited in Vousvouras and Heierli 2010)

One of the factors which impedes the development of clean water technology in the BoP is lack of essential information among the poor about the health benefits of water purification. And for an entrepreneur it is not enough to minimize cost as much as possible while offering a product of an adequate quality in the market, but in order to generate demand, relevant knowledge of the product benefits must be imparted to the potential consumers. Moreover, to make a water purification product accessible among wide range of poor consumers, companies may rely on NGOs for selling

their commodities as well as implementing educational process. For instance, mentioned above PSI organization is one of those who makes a goal to motivate vulnerable populations to adopt healthy behaviors by different forms of social interaction, from radio and print media to one-on-one outreach in remote communities. Such form include a practice, when a community health worker explains to a mother the right way of treating drinking water for her family at their home.

In the United Nations High Commissioner for Human Rights' Fact Sheet No. 35 called 'The right to water' (2010) it is stated that in obtaining access to safe drinking water "poorer households should not be disproportionately burdened with water and sanitation expenses ", which implies that cost-recovery issues should not be an impediment for people of any economic status, especially for the poor, to access water for personal and domestic use. This regulation was mentioned in the Plan of Implementation of the 2002 World Summit on Sustainable Development. In accordance to this requirement the governments of economically developing countries and corresponding authorities should be strictly responsible for the support of its poor citizens in providing them with affordable potable water. Alternatively, general comment No. 15 by the Committee on Economic, Social and Cultural Rights asserts that governments "should adopt the necessary measures that may notably include appropriate pricing policies such as free or low-cost water ". Owing to this directive, the development and market of clean water technologies in the BoP sector should be carried out with the serious aid of governments, while various enterprises of water products and technologies for the poor should seek this cooperation from them.

Due to lack of environmental education and in contrast to manifest necessity and priority of delivering water and sanitation services for satisfying basic demands of population, the realization of communal wastewater treatment has little progress in developing countries as it has little governmental and public concern (OECD 2011). It follows that, environmental ignorance of authorities as well as individuals should be liquidated, while the real benefits of wastewater treatment should be introduced to the decision-makers. On the one hand, governments are the ones to deal with the environmental issues of the countries they rule. On the other hand, governance implies control over pollution among enterprises and businesses situated within the country's borders. That is why investing in the market of clean water technologies "kills two birds with one stone" at least, whereas wastewater treatment technologies also bring incontrovertible benefits to the communal water quality specifically and entire freshwater ecosystems in general.

Diminished and low concerns about environment in comparison with other interests appear to be serious restraint in clean water technology development and proliferation in emerging markets.

Present environmentally-oriented parties lack for ability to influence on the decision-makers towards allocating enough finances for implementation of environmental projects with the appropriate technology use. In addition, centralization of funding means identified for environmental concerns encounter inadequacy of financial independence at different levels of governance. Another trouble occurs due to inept substantiating of demand for environmental assistance and lack of authoritative parties showing potential for decent fulfillment of the projects. There is a vast gap exists between the amount of means needed for the proper water treatment realization and the amount of means available for it. What's worse, even the assigned means for technological advancement in water treatment can eventually serve some other purposes or disappear at all. Such circumstances also weakens motivation and responsibility for environmental activities realization. To address this situation, water supply and sanitation services which imply proper water treatment technologies use, should become of great priority for targeted financing. (UN 2004) As a matter of fact, since the repercussions of disregard to environmental protection would likely impact at first the most vulnerable social segments, the poor, it is highly relevant for all the agencies willing to alleviate their share, to think beforehand and prevent such outcome by involving heavy investments in the protection and sustainable use of water resources. Clean water technologies are almost the only viable tools to promote water resource protection and maintain safe water availability in the long term. To recapitulate, it is always far more sensible to take preventive measures against possible disaster than struggle with negative consequences what in most cases requires much more time and resources to be involved.

In low-income countries, authorities responsible for the accomplishment of water projects, together with the financing institutions are somehow persistently disinclined to contribute in the technology market growth. What's more, it turns out that existing facilities with the involvement of water treatment, happen to offer service of short duration, wherein the long-term vision is not usually thought over. Hence, the problem of maintenance of the systems become more and more acute in growing amount of cases. Due to weak institutions and deficiency of monitoring options technical sustainability of water projects often experience failures. Even though a lot of programmes have attempted to enhance private sector participation in the instrumentation and primarily maintenance of the water systems, such enterprises find too few options to survive. The markets of water technologies appear to be very scarce and occasional in order to offer proper business projects. Therefore, additional troubles come, for example, when already installed systems require repairing with the need of spare parts, and especially when whole technological elements have to be replaced. Without governmental in concert with assisting parties' support in

form of subsidies and sufficient investments water technology markets in developing countries would be likely doomed to lack progress. (OECD 2012)

Prahalad (2006) asserts that in order to generate success with any product, service, or technology in our case at the 'bottom of the pyramid', the design of an innovation of these goods should begin with conforming to the four following prerequisites:

1. The innovation must result in a product or service of world-class quality.
2. The innovation must achieve a significant price reduction — at least 90 percent off the cost of a comparable product or service in the West.
3. The innovation must be scalable: It must be able to be produced, marketed, and used in many locales and circumstances.
4. The innovation must be affordable at the bottom of the economic pyramid, reaching people with the lowest levels of income in any given society. (Prahalad 2006)

These rules are comprised by the 'Innovation sandbox' approach, named by its author. The approach has proved to hold great value in the low-income markets. And the rules have no exception for the clean water technologies development in the 'bottom of the pyramid'.

One of the two originators of the BoP concept, Stuart Hart, standing by the initial proposition, offers kind of update on the idea and introduces the 'version' BoP 2.0. He believes that BoP 2.0 would serve as regenerated approach of the 'BoP 1.0', which suggests that the business in the BoP market should be made by close collaboration of the two parties, local communities and companies themselves. Bringing mutual understanding, cooperation of these sides would be able to build innovative, sustainable long lasting solutions. Hart ponders over the thought that simple price reduction of a product and offering it to the poor would not be always successful. On the contrary, experiences of quite a few enterprises, which tried solely to move goods from the 'Top of the Pyramid' to the 'Bottom' categories, ended up with failures. In order to come closer to success, author posits, that one should think about generating new categories and together with the end-users create an appropriate value proposition. And that is one of the ways to develop the market, while attaining fortune for all included in it. (Mahajan 2013)

Hart and Christensen (2002) argue, that ample markets of economically developed nations are oversaturated and cannot promise prolific growth and expansion anymore, whilst the base of the pyramid, obviously, is almost entirely unclaimed. Learning from the words of authors, the BoP

market is also a place, where "the technologies that are needed to address the social and environmental challenges associated with economic growth can best be developed". For this reason, the world of developed market economy has to begin sharing technological advances with the undeveloped markets and its populations.

Markets of developing countries are the better ground for companies to achieve success also due to the fact that they can offer a service or a product to population, which would otherwise either be neglected or niggardly served by available in deficiency and of bad quality goods. This principle is referred to disruptive innovation and in application it makes companies compete against non-consumption. (Hart and Christensen 2002) Given the critical necessity of water purification and water treatment technologies and products in the developing countries, we have every reason to believe, that BoP market is the most relevant space for the deployment of discussed business models.

3 TECHNOLOGY TRANSFER OF WATER TECHNOLOGY TO THE BOP

It is common knowledge that economic progress requires vast exploitation of natural resources, as historical period of industrialization has demonstrated to the world. Accelerating pace of industrialization in developing countries increasingly contributes to the global environmental issues. This reason alone already creates motives for putting into effect the technology transfer of sustainable technologies from the developed world to developing one. Such technologies have to be resource-efficient and cost-effective in order to sustain world's productive capacity. But most of all they should be environmentally sound. Today progressing engineering and scientific knowledge of industrialized wealthy world let developing nations have an opportunity to leapfrog the 'dirty stages' in technological development and avoid repeating the blunders of industrialization phase, which may lead to environmental collapse, taking into account that present ecological condition of emerging nations which are trying to progress, is already critical. Furthermore, besides preserving natural resources environmentally sound technologies allow to enhance productivity. (Aloisi de Larderel and Whitelaw 1998, Perkins 2003)

All of the mentioned benefits would be brought above all to developing countries by clean water technologies because water lies at the core of sustainable development and is essential for almost every single creation process and life activity.

Water technology transfer among the capacity building projects and mobilization of assistance parties is promised to promote “access to safe and affordable drinking water and basic sanitation for all, as necessary for poverty eradication, women’s empowerment and to protect human health, and to significantly improve the implementation of integrated water resource management at all levels as appropriate” in particular, to developing nations. Thus General Assembly announced in its famous 66/288 resolution. (UN General Assembly 2012)

To date, it is plainly evident that technology transfer implemented in a developing country is also able to bring advancements in quality of life, enhance the economy, simultaneously providing more people with jobs. Alrusheidat (2004) deduces curious thought, that when people are given a new technology for their development, they become better educated and purposeful to pursue a career, which might result in the family size reduction, which in its turn leads to demographic stabilization. Less people consume less natural resources, in particular, water.

As early as in the year 1972 Stockholm Declaration of the United Nations Conference on the Human Environment raised a question about significance of technological assets in respect to combating of environmental deterioration. The participants of the conference made an appeal to the public and authorities for intensifying of collaboration between governments in the area of environmental technologies, emphasizing the special need for technology transfer to the developing nations, “on terms which would encourage their wide dissemination without constituting an economic burden” (Stockholm Declaration 1972). (Chuffart 2013)

Over fifteen years ago UN (1992) convention on climate change resolved on the decree which reads that developed states around the globe “shall take all practicable steps to promote, facilitate and finance, as appropriate, the transfer of, or access to, environmentally sound technologies and know how to other Parties, particularly developing country Parties.. In this process, the developed country Parties shall support the development and enhancement of endogenous capacities and technologies of developing country Parties.” Counteraction to the change in climatic conditions builds on utilization of best available clean technologies which aim to preserve natural resources and prevent environmental pollution. In this respect, realizing that water resource reciprocally influences on, and impacted by, the climate change, everyone ought to promote, facilitate, develop and implement the transfer of clean water technologies in every place in the world where it is needed, essentially to developing areas.

At the Conferences of the Parties (COP) the technology transfer issue was repeatedly highlighted on the agenda. For instance, at the recently held COP in Dona it became a prime topic of formal talks. Within the report of Technology Executive Committee of the Convention the key messages on enabling open possibilities for, and mitigating obstacles to development and transfer of sustainable technologies were discussed. One of them reads as follows: "the enhancement of developing countries' capacity to assess, absorb and develop technologies". (Chuffart 2013)

At the present time politicians of industrializing countries are attempting to draw MNC's investments into emerging market economy in anticipation of gains which will be brought along, and brought technology transfer possibilities are counted as some of the most beneficial features. One of the profits allows developing nations to obtain fully developed and the most advanced technologies by means of technology transfer bypassing the own stages of R&D undertakings and corresponding large investments in it (Pansera and Owen 2014).

On account of increasing environmental concerns across the world due to overall nature resources degradation and climate change implications, developing nations should reckon with the collective responsibilities for the consequences of unsustainable path of development.

3.1 Potentials of clean water technologies and solutions transfer to the BoP

Technology transfer (TT) term appears to be ambiguous due to distinction of its various forms, such as importing or exporting of resources, commercial transfer, scientific dissemination or dual-use, depending usually on its purpose, involved parties and attributes. Simply, TT determines a "process by which technology or knowledge developed in one place or for one purpose is applied and exploited in another place for some other purpose". (UTRS 2015) The expression TT is also difficult to interpret because of its word technology itself which can be so differently evaluated and observed by specifically minded individuals.

However, excluding an opportunity to confuse the meaning of TT implied in the present research, we mostly intend to use widely accepted definition of the Oxford English Dictionary, which reads it as "the transfer of new technology from the originator to a secondary user, especially from developed to developing countries in an attempt to boost their economies" (Oxford University

Press 2015), emphasizing that we are interested in the delivery of a technology to the poor by any assisting or business organization, in particular, MNCs or any other business companies.
Nevertheless, in the case of TT involved in a business strategy, does the solely purchasing or selling of a technology frames the TT concept? It happens, that often a participator selling technology to developing country simply considers his duties completed when the technology is imported. Such attitude, in fact, brings a lot of difficulties for the party obtaining technology in terms of inability to assimilate, maintain or sometimes even realize the working principles of it. Certainly, TT turns out to be much more profound and complicated thing than just an action of selling of a technology to a client, and consists of conveying of knowledge of the technology, essential skills to deal with it, methodologies and range of other features which jointly allow technology to be viable and properly applied in the place it is delivered to. (GDRC 2000) TT implies the use of knowledge, hence, speaking about transfer of technology, it literally means the transfer of knowledge by means of TT agreement between the transferee and the purveyor. TT is not about just moving or delivering of a technology, but TT takes place only if technology (knowledge) is eventually used by the transferee. (Seth Associates 2008)

Prahalad and Hart (2002) believe that countries with lack of present-day infrastructure and products to address their fundamental needs, are “an ideal testing ground for developing environmentally sustainable technologies and products for the entire world”. As challenging as it sounds, authors also admit that “it takes tremendous imagination and creativity to engineer a market infrastructure out of a completely unorganized sector.”

However, the problem is indeed, only begins with the market infrastructure, solutions to which is discussed in previous chapters of this research. The history of struggling to achieve successful TT implementation in the low-income countries is full of failures. Obviously, there is a strong potential in the TT concept, however, attempting to fulfil the transfer, a number of economic, social and environmental factors so often become an object of disregard or omission which leads to persistent defeats. Talking about transfer of appropriate technology in water and sanitation sector of developing countries, it is worth to note that Multilateral Development Banks (MDBs) among various International Assistance Agencies (IAA) for decades have been troubling with the meager, ineffective results of hundreds of TT attempts. For instance, nearly three dozens of water supply facilities built by IAA in Thailand, are malfunctioning. Similar destiny has come upon fifty urban sewage treatment plant projects. As Ludwig (2006) claims, same situations occur in all developing nations of Asia. To solve the paradox of consistent failures, author applies few decades of personal experience as an environmental engineering specialist to define special criteria which

TT operators must be conformed with, in order to reach projects' viability in the developing world. The criteria include feasible measures due to which TT projects can be successfully realized. Among these measures there are following points:

- post-development monitoring of project performance;
- developing applicable design criteria for major infrastructure sectors;
- pragmatic approach on operation and maintenance expectations;
- enhancing the fiscal involvement in provision of proper infrastructure for the TT;
- leaving relevant technology documentation and various literature;
- sponsoring of graduate university programs in apropos TT as well as training tasks such as temporary working experiences in the developed countries;
- progressive planning and implementing of TT projects;
- attempting to engage retired stuff of developed nations to be in charge of training and educating practices (and not for just 'observing').

Regarding to the problems of environmental engineering infrastructure in developing world, Ludwig (2006) puts forward a fact that water resource protection projects in most cases consume investments without creating monetary outcomes. That is why in low-income communities the concern for water quality is commonly neglected, while water supply none the less is considered necessary for public and industries. In comparison with investments in other projects for population such as airports, roads, buildings and so forth, which are economically beneficial due to paybacks and produced revenues, investments in water treatment sector is considered not reasonable enough by authorities because of its inability to be economically viable. Meanwhile environmental and in the long term health benefits usually are left in the background. Therefore, it is becoming more and more crucial nowadays to refocus attitude and attention of governance and assistance agencies towards devoting significant share of means to the clean water projects, involving modern technologies for waste water treatment, reuse technics and other environmentally essential activities. In this way, TT of clean water technologies becomes to be indispensable for the proper water management and preventing degradation of the water resource in rapidly developing low-income nations. However, these investments in TT projects, indeed, should not be merely about rendering fiscal means to the water management sector, but it should include post-construction monitoring of the built systems for the successful result, as mentioned in the listing above. Besides, TT in the sphere of water supply or waste water treatment should avoid frequently applied counterproductive approach of delivering to developing countries systems which are designed in the industrialized world for its own specific use and design criteria

meeting local environmental regulations of wealthy nations. In this respect, technologies, products and systems meant for TT to developing countries must be specifically adopted or entirely designed for the unproblematic and comprehensive use by the transferees. Following these rules, appropriate technology should also reckon with realistic situation in the poor communities in regards to economic ability to provide operation and maintenance for it in the long term, in other words to be feasible. (Ludwig 2006)

Implementation of TT depends on adequate management of the operation. So far as we know, it is a common trouble for the receiver of technology in developing countries to provide a proper professional or a specialist for knowledgeable coordination and arrangement of the TT operation. Because of the lack of required skills and abilities from the receiving party the operation aggravates as well. Nevertheless, discussed above measures come to help to overcome such issue. What counts here, efficient collaboration of two sides depends on mutual understanding, meticulous attention to details and joint desire to reach success. (Ramanathan 2003)

From the commercial perspective implementation of TT is one of the ways to increase a company's competitiveness by virtue of rising the customer value (Ramanathan 2001). There is ample evidence that value creation potential is widely available nowadays in the large unserved markets of developing countries with the escalating population growth and therefore growth of the purchasing power. By offering TT to the poor, their value will inevitably increase, so will commercial benefits to deal with them further and further. Moreover, equipping populations with the clean water technologies will definitely bring colossal improvements in social, economic and environmental sectors as the previous part of this research has discussed. The lives of populations will be improved, their financial situation as well. Thus, BoP market will appear more and more attractive in commercial aspect to the rest of the world. That is why the TT of clean water technologies to the BoP holds the key to eliminating range of serious problems and creating favorable opportunities at once.

International TT has attained a large potential of advancement after globalization process has begun across the world as well as liberalization of the economic regimes. After the World Trade Organization was established, protection of intellectual property (IP) rights has also brought benefits into spreading and enhancing of TT, however, not for low-income countries wherein such feature appears to be a hurdle in the TT operations in commercial regard, obviously, due to poor economic situation. (Ramanathan 2003) Chuffart (2013) notices that institutions of industrializing nations are fragile in a in a substantial way to the liabilities and dangers of IP rights exertion because the poor governments and their countries commonly experience troubles dealing with the legal intricacy of patent licensing and financing expenditures intolerable to their economic

situations. For this reason authorities of developing nations strive for evading a hurdle of IP regimes and licensing arrangements which indeed, frequently conflicts with the interests of parties supporting it, particularly, industries and various firms (Daño, Wetter and Ribeiro 2014). Seeking for a compromise might be an option. Among global solutions to eliminate barriers of technology transfer caused by the protection of IP, "compulsory licensing of environmental technologies or reduction of the duration of patents" was proposed. Also, considered as one of the most realistic ideas, creation of environmental patent pool would greatly facilitate technology transfer implementation, though for the involving the least developing countries in the participation, some amount of funding would be necessary. (Chuffart 2013) However, there is another even more suitable option. Advocates of open source appropriate technology (OSAT) attempt to assist destitute populations of developing countries in acquiring technologies needed to combat their harsh circumstances and to preserve natural resources. Paying attention to challenging conditions of billions of poor in the BoP, Pearce (2012) insists on very rational solution of creating free access to the most essential environmentally friendly technologies for offering an opportunity to achieve sustainable development in the low-income countries which are soon to struggle with environmental issues more than with economic, social or any else, and thus threaten global environmental situation as well. The clean water technologies would be in the forefront of this solutions' collection. Author promotes the idea of OSAT claiming that the technologies which have power to defeat world's poverty, environmental degradation and enormous rate of preventable deaths, are not available for those who need them the most, developing populations. Pearce asserts that "This lack of access to critical information for sustainable development is directly responsible for a morally and ethically unacceptable level of human suffering and death".

3.2 Water purification technologies from Finland

Since 2000, Finland has been positioned as number one in terms of sustainability, above 142 countries, which was evaluated with by World Economic Forum with Environmental Sustainability Index (ESI) to measure overall progress towards environmental sustainability. During decades Finland accomplishes excellent environmental protection and sustainable development policies among the rest of the world, special attention is dedicated to minimizing air and water pollution and to organizing institutional capacity to deal with environmental issues. (Lindblom 2004)

Commission for Sustainable Development (CSD)-12 Bureau has endorsed successful in sustainability management countries to share their advantageous experiences and provide achievements practices on implementation with less successful countries. To spread the knowledge and offer aid in tackling environmental problems, Finland has prepared a case with the following examples of best practices on sustainable water management (Lindblom 2004):

- Integrated Water Resources Management
- Efficient Water Consumption
- New Approaches for Water Protection
- International co-operation on Water Management

These examples are considered to be relevant for other countries in terms of sustainable consumption and production. However, their applicability in the developing world might be subjected to criticism, taking into account initial conditions, wherein Finland possesses a vast store of exquisite water resource, and most developing countries have critical water shortages together with quality degradation. As the case stands, in order to assist developing nations with the water management issues effectively, all policies and technologies should be planned with adaptation to specific needs of the regions. Besides great improvement in health insurance and well-being, successful implementation of water technology transfer from Finland to developing countries would significantly promote sustainable development in the third world countries.

Finnish report on freshwater and sanitation country profile (Lindblom 2004) particularly relates to education on water issues in developing countries. It is emphasized that "Finland needs to strengthen training, research and know-how related to water issues in developing countries, particularly for the younger generation. This calls for a long-range action plan." Furthermore, in regard to international cooperation in water problems Finland will likely "continue to be provision of Finnish expertise and assistance to promote integral planning of the use of water resources, development of administration and legislation, and building up capacity in developing countries". Exercising participation in individual projects is considered to be of great value. For instance, Finland has implemented capacity-building projects in developing countries as well as countries in conditions like Kosovo, Thailand and Kampuchea. (Lindblom 2004)

Ministry for foreign affairs of Finland declares, that on account of internalization of exacerbating environmental issues and enhancing role of globalization, there is a pressing need for uniting the environmental and trading perspectives together. Therefore Finland persistently engages in the course of abatement or full eradication of the trading obstacles in relation to environmental

services, technologies or products and particularly technology transfer. Developing countries would vastly benefit from approbation and acceptance of these Finnish initiatives because it would become less expensive and less perplexing to implement the transfer of clean technologies from Finland to the low-income communities. Hence, "this would strengthen the freedom of choice of developing countries to choose the specifics of their development strategies according to their own needs and priorities, as required by the goal of sustainable development." (Kehityspolitiikan yksikkö 2010)

4 METHODOLOGICAL CONSIDERATIONS

In order to address rapidly escalating problems of inadequate access to safe water in developing countries as well as in the whole world, it is imperative to learn the actual causes of the issues and inspect physical, social and environmental impacts. Present research particularly is meant to pursue such course by applying holistic, analytical analysis of available literature and relevant speculations. After exploring a range of reasons of the safe water crisis in the developing nations, research consistently continues in in-depth investigation of existing and potential solutions to the issue. Specifically, among the analytical discussion of possible or already implemented solutions in the poor communities, a number of water purifying technologies and products which appear to be applicable in the BoP markets were examined. The challenges and opportunities of business enterprises at the 'bottom of the pyramid' were also thoroughly considered, taking into account various factors, actors and solutions within the development and market of clean water applications. A profound thought was given to the aspect of technology transfer from industrialized world to the poor nations. Besides, three case study approaches were implemented through interviewing of chosen Finnish water treatment companies. The results of these interviews are presented in the following chapter.

The idea of this research is that it is crucially important to realize how clean water technologies have a power to bring progressively positive changes in almost every area of human's existence as well as to forestall the complete environmental and natural ecosystem's destruction. Hence, embracing critical situation with safe water issues in the developing world, this paper studies the role and potential of water technology transfer to the BoP market among other inspected solutions. Practical matters were observed during the data collection, which question a possibility and available options of clean water commercial technology transfer conducted by Finnish companies

through making business with the BoP sector or at least developing countries in general. The theoretical framework of the study is based on mentioned above concepts.

In accordance to Sapsford (2006), philosophical standpoints which underlined the way this research was carried out, relate mostly to objective review of publicly available literature, however, an element of subjectivity might have assisted along the consistency of speculations.

Present paper involves both document analysis and case study research methods. As for methods of examination, predominantly qualitative analysis have been employed, even though considerable amount of primary and secondary data including statistical reports relied on quantitative analysis. Thus, in data collection process the following sources of information were scrutinized:

- Primary information (various kinds of literature, such as relevant studies, scientific researches, journal articles, statistical and assessment reports, books, publications of different organizations and scientific communities, including universities and professional institutions, as well as web sources of related data).
- Secondary information (interviews with the representatives of Finnish water treatment companies and research experts of the university where this paper's author belongs to).

Primary material has been acquired generally by the means of internet resource through electronic databases with the access of university's library. Secondary data has been obtained through in-depth personal interviews with the directors and managers of Finnish water treatment oriented firms as well as with university's specialists. All of the informants kindly agreed to discuss the matters of preliminary composed discussion guide which was sent to them beforehand. The discussion guide as well as utilized open questionnaire can be found in annex section. Some information was obtained through e-mails. Besides shared knowledge, insights and opinions on the subject of present research, informants also personally provided some secondary documents, hands-out and advices in regard to analysis facilitation.

Data analysis has been performed primarily as qualitative examination of explored, learned and collected knowledge and materials. All presented figures and tables are made in accordance with scientific guidelines, properly referenced and mentioned in the text for corresponding deductions.

The research has been carried out during the year 2015. In spite of realistic expectations, it appeared to be quite complicated firstly to choose suitable individuals for the interviews whose knowledge would address formulated for the research questions, secondly, manage the

appointments with these individuals due to their busy occupation, and thirdly, even when an agreement was given and a meeting was appointed, some disappointment was caused from the realization that an informant might not possess needed knowledge or even a company itself doesn't actually engage much in the processes which have been expected of it and which would help to shed light on the aspects studied in present research. These issues, however, were coped with, which lead to marginal modifications of the research's goals.
Whole process of the writing was conformed to the ethical guidelines of the university it was conducted at.

4.1 Identification of Finnish companies dealing with water technologies

For the current research three Finnish companies have been chosen and meant as the case study analyses objects, including Kemira, Outotec and Fenno Water. All three firms are dealing with water treatment processes and have shown a potential to contribute in the research's issues by offering a possibility for interviewing. Thorough inspection of internet pages of the companies have brought a suggestion that the data on technology transfer aspect would be obtained through an inside employee. It stands to reason, that some risks have been assumed and taken into consideration due to predictive nature of investigation and inability to have a precise and authentic information on the fact in what extent these chosen firms would actually contribute to the research. Thus, subjectively, it appeared to be that the most relevant data has been acquired from the Kemira's party. The other two companies have also brought beneficial data, however, in smaller scope than it was expected. Generally, gathered data from chosen companies somehow differs in its content. Admittedly, such variations might have occurred due to human factor or personal resistances to disclose some company's information on a particular topic. The focus of interest was on municipal and drinking water solutions, including technologies and products as well as some of the waste water treatment technologies offered by chosen firms.

For the brief introducing of companies, next information and statements are extracted from the online resources and presented as follows. Any additional data on the companies' activities can be found online through their web-sites.

Kemira is a "global chemicals company serving customers in water-intensive industries. It provides expertise, application know-how and chemicals that improve its customers' water, energy

and raw material efficiency". The company serves both municipal and industrial customers to enhance their water treatment efficiency by offering expertise and chemicals for raw and waste water management. Concerning drinking water, Kemira provides range of safe and reliable solutions for purifying water of various nature of contamination. (Kemira 2015)

Outotec "provides innovative solutions for industrial water treatment", including such technologies as neutralization, effluent treatment, drinking water solutions. (Outotec 2015)

Fenno Water Ltd Oy "is focused in water supply and sewerage engineering for Industrial and Municipal projects. Our know-how is process design and manufacturing of water and waste water treatment plants". (Fenno Water 2015)

4.2 Data collection, results of the interviews with Finnish companies

4.2.1 Kemira case

Following below data has been obtained through personal discussion with the Riikka Timonen, Kemira's Director of Sustainability, on December, 2015.

Kemira supplies its technologies and products to the industrial and municipal water treatment facilities. Basically, wide range of chemicals is offered for treating raw water, drinking water and waste water. Typically, in European market company provides all of these options, however, the closer it gets to the so called BoP market, the focus shifts from waste water into raw water and drinking water. So, what Kemira currently supplies, for instance, for the African countries, is chemical technologies for treating the drinking water. Chemistry for the desalination facilities is also provided, giving an opportunity to produce clean water out of sea water. Such solution is needed not only for acquiring of potable water, but also in the process of developing membranes, wherein keeping the membranes clean and operational in longer term is very important. And then finally, company also supplies some chemicals for slush treatment. In fact, majority of water treatment processes always have by-products, when impurities from water are separated, and from these impurities slush occurs. The slush is difficult to handle due to its high moisture content, so Kemira proffers quite a lot of chemistry for de-watering the slush, i.e. taking the water away from the slush so that it can be later transported and further processed.

Elaborating on municipal and drinking water projects which are conducted in developing nations, Timonen mentioned, that Kemira does not have projects as such, and it is about normal business-to-business operation, where company provides solutions to a customer. Indeed, Kemira is trying to seek for new customers in those markets (BoP markets) for treatment plants, new and existing, in order to supply them with various chemistry products. And in large amount of cases that also relates to assisting customer with some technical advices, for instance, how to improve the overall efficiency or the treatment result of those facilities with the help of tailor-made chemistry.

From the Kemira's perspective, technologies offered either to some Europian countries or developing populations, as such are not that different. For example, as was mentioned before, in Europe the focus is a lot on the waste water side, but the poor countries are not so interested in the waste water treatment, yet. Obviously, that they have an interest towards providing clean water to the people or the industries. So, this is a difference between having business with the BoP or some country of industrialized world. The other difference is perhaps, in relation to the process itself of making business. In European countries the procurement processes are regulated and structured in some extent, while in the developing nations "you have to do much more work to understand really how the process works and who is going to be the decision maker, and where does the money come from etc." And one more difference is about opportunities which Kemira can have in the growing BoP market. On the one hand, the more company goes into the poorer countries, the less water treatment facilities are found to supply with Kemira's solutions, however, on the other hand, that market is really growing together with the number of customers. So new players are coming to the market all the time.

Surprisingly or not, Kemira's position is strictly designated as "simply pure business", based on the business rules, so the company has not sought for any subsidies, support or collaboration with the NGOs so far in order to implement its business strategies. However, that is because in many cases the funding or the support mostly goes to the projects that relate to building the infrastructure. For instance building a water treatment plant or waste water treatment plant. But Kemira is not really involved in this kind of infrastructure formation, even though what is worth to notice, a basic infrastructure is essential for the Kemira's business options. Kemira is a technology provider to the running facilities of municipalities or industries, and not directly to end consumers. Summing it up, none of Finnish subsidies nor foreign come into aid of Kemira's business with anyone, rich or poor and all the commercial processes happen internally. Nevertheless, later in conversation Timonen mentioned, that indeed, in the Kemira's group level, it is common to have CSR activities. For instance, Kemira has had an experience with the fulfilment of corporate responsibility programs in China. "But that was not a business project, it was more that we just helped the local

people and villages in china to get better access to raw water, clean drinking water and then to treat the waste water, to protect the surface waters. But that was not business related, that was more sustainability related, and was not connected to our business activity."

Speaking about the profits a company may have in dealing with the poor, Timonen notices that for Kemira there is, actually, similar level of profitability brought by any customer, either of developed or developing country. So, Kemira does not really make a big difference in regards to the poor economies or to the rich economies. Basically the same business rules apply. Of course, nowadays when thinking about water treatment business, Kemira has gained a very solid position in the European market, but for instance, in the African market company is not that strong. So this (Africa) is a market where Kemira now is very actively looking to grow, considering that BoP is a "huge untapped market" for the company. In addition, European population (whom Kemira widely works for) is not growing strongly, neither does the GDP. Hence, there is not much growth in these current established markets. For Kemira, the emerging markets are clearly the growth engine. "We are seeking growth from those markets", emphasizes Timonen. And of course when you are thinking of growing strategically in a new market, you might be willing to sacrifice some of the profitability part in order to really enter a new market. So maybe there are some low level expectations in regards to profitability in the BoP, but that has nothing to do with the fact that the market is poor or rich. It has more to do with the fact that entering into a new market is a strategic interest. As for risks and disadvantages it may bring, there can be different contract terms, payment times or delivery terms or sometimes price related issues. But in general, company attempts to create the same level of profit regardless of the market.

Timonen expressed, that the issue of affordability of water treatment technologies by the low-income countries is a good question, however, which is not easy to answer, at least she could not offer a concise opinion. The matter of affordability depends on how the infrastructure is being built and organized in each specific country. And of course, Kemira is selling water solutions mostly to the water treatment plants, so it is not involved in the decision countries make regarding the local water tariffs. Thus, it is rather a concern of governments or municipalities or private sector about how to make services with utilized Kemira's solutions affordable for the populations.

Kemira transacts business with both, governments and private enterprises depending on how the supply of water and waste water treatment is being organized in a country. Company has industrial customers in some countries, where water treatment organizations are not being managed by the governments or municipalities but private sector, hence, the entire industrial water treatment processes are being privatized. Such occurred in the UK for instance. But then in other countries,

like in Finland for instance, it's a municipality who rules the management, so then the municipalities are the customers. Kemira also is working with the local enterprises of developing countries apart of MNCs which always promise to be profitable to make business with.

In regard to technical feasibility of Kemira's products in developing world, Timonen said that even though their chemical solutions are quite easy to apply, and often it is a basic chemistry being sold to the poor, nevertheless, Kemira conducts regular trainings with the customers and trains them how to choose the right chemistry and how to use it in the right way (how to dose and how much to dose, and so on). "Like the last time we had a technical customer seminar in Ghana, Africa, in October. Our experts from Sweden flew over there and then trained the customer's operators hand-in-hand for one week".

The technology transfer process itself for Kemira is not difficult to implement by the words of Timonen. "Water treatment chemistry is not rocket science", she says, "it's been done since the bible ages". Basic chemistries, sorts of inorganic acids, are being used to remove impurities from water. TT here has more to do with a kind of efficient supply chain. Company has to be able to manufacture these chemistries and then deliver and supply them in an efficient and secure way, so that it can secure clean water to the customers every day, throughout the year. These are the priority and where Kemira's strengths lies in, more than in really high level of intellectual property business, for instance related to Kemira's chemistry. The company has some proprietary technologies but not too many. Moreover, when Kemira in an attempt to protect IP rights of a technology "signs a contract with a local supplier ("we of course always want to sign a non-disclosure agreement and this sort of things"), then "at the end of the day in many of these markets it doesn't matter what kind of agreement you have. I mean, they won't tell you anyway." And then in regards to our proprietary technology, we are of course actively protecting our innovations, for instance, with patents. Surely, Kemira has an intellectual property strategy. But again, it is difficult in the poorest countries to manage with this issue, "even though you'd see that someone is breaching your patent, the justice system is not working in the poor countries". "So there isn't too much that you can do in practice, at the end of the day anyway. And sometimes we decide, that we won't bring certain technologies, some proprietary technologies of high value, into certain countries. We really realize that it could be stolen."

Then, if you think about overall kind of technology transfer, so it is not so much related to our technology as such. It is related, in Kemira's case, to the message that how important water treatment is, especially drinking water treatment, but also raw water treatment and why you need chemistries there to achieve a good result. Thus, in many cases according to the personal

experience of Timonen, is that in the poor countries people don't see the links between raw water and waste water treatment. It can be that the poor consume a pumped ground water for drinking water purposes, and at the same time they discharge all the waste waters untreated into the surface waters. So they don't see the water cycle there (in poor countries) that we see, and this is the big message that we show in many cases to the poor countries, "it is the same water that comes around in the environment and you cannot be pumping the groundwater forever". Also, it is important to remain the surface waters in a good condition, so it can be utilized as a raw water source. "This is the kind of big message that we try to bring along in the developing nations. The kind of overall awareness and importance of protecting the water sources". However, this attitude is not born out of sole generosity in Kemira's strategy. The logic is that "the more they start to treat the waste waters, the more business it is for us", Timonen believes. It is a logical reason for those educational practices. "I am not saying that we are a welfare company, we are a business. There is a strong reason why we see that it is important so that the people also understand the significance of maintaining a good quality in the surface waters".

What comes to a potentials in respect to promoting business with the BoP, Timonen says following. "Certainly, Kemira is constantly developing new technologies for different cases, as for the BoP market, they have a bit of different need in their pursuits. Like for example if you think about how the water supply has been organized in Europe, imagine big centralized water treatment plants and piping which has been laid under the ground before building of other structures and so on. This for instance might not be the case in some developing countries, they have a lot of big cities that have absolutely no piping at the moment, no water infrastructure. So of course the technologies need to be different as well, to make sure that people have access to water supply and waste water treatment. But we cannot rely on the western way of organizing things. For instance technologies that are maybe just equipped for one house, or one local apartment, might be more relevant than these big centralized water treatment facilities that we are used to having here in Europe. So, in order to have business there, in the BoP, we have to adapt, to play into that market."

Discussing the impediments which lie on the way of progressing into BoP market, Timonen notices, that one of the obvious barriers in TT for Kemira is the question related to the supply side: how to procure a secure and cost efficient supply of the chemistries. "Of course, if thinking about investing in a water treatment chemical facility, then in a poor country it can become problematic, because if a given local engineering company or a local construction company fail to collaborate, then we notice that after half a year there is an exactly the similar type of a manufacturing facility built in the next county, or so. So we haven't found any philosopher's stone really, and of course

we understand the risk, and we try to protect ourselves to the best of our ability. But we have not really figured out a complete solution to that problem".

Another obstacle consists in poor knowledge of the BoP market by western companies, and Kemira is not an exception. "So it is important to realize how the water sector is being organized in a developing country and who the players and customers are, and how does the money flow, and so on... Firstly, in many cases the infrastructure in a low-income community, if exists at all, different to what we are used to be dealing with. The second issue is of course how to understand really what the driver is. In Europe, for instance if you think about waste water treatment, in many cases the driver for building waste water treatment is the regulation. And in many cases in the poor countries such regulation does not exist. So there is no really a business driver to invest anything to waste water treatment when there is no regulation for that. So that is another hurdle. Third hurdle is of course related to business ethics. Unfortunately in some cases of the poor countries, dealing with the government or local authorities reveals a bribery problem. And corruption is a topic, we cannot be involved with. We cannot be involved in any unethical business behavior. Basically that is a complete no-no for us, for Kemira, as a stock-listed company. We have our own code of conduct that we need to follow strictly and be completely transparent in our operations. So sometimes it's a hurdle for us to see whether we can find ways to do business according to our own code of conduct. Sometimes it is not possible." And that is one of the reasons why sometimes Kemira prefers to have business with private sector as with more reliable choice.

It also turned out that Kemira's technologies do not commonly find a difficulty to be utilized in the developing countries, as Timonen pointed to. In addition, she said, that she cannot name any external factors which would impact the viability of a product or technology in the BoP. ". It is more like what a customer and a market needs in terms of a specific country. And of course we seek to develop and sell the best options in that particular market". Furthermore, the idea of collaborating with the potential customers or even end-users of developing countries aiming to create adapted and appropriate solution, is assimilated into company's strategy. Thus, Timonen noticed "we are constantly developing products that fit to the specific market needs."

In addition, Timonen has shared her view on the water crisis of developing world in general terms. She expressed that "first of all the whole thing should start from awareness. Local awareness of importance of protecting the water sources. Next, today, with the ample availability of existing technologies the trouble is the delivery and installation of them in the poor countries. The problem is really: who is going to pay for the investments? And that is the kind of biggest hurdle. Who is going to pay for those technologies, to be installed? And then finally 3rd element, where I think

that technology development has a role to play, is smaller scale water treatment facilities. So that we would not have to start building a big mainframe, put pipes to a ready constructed settlement, but we could for instance install a small water treatment unit to a block house. So those sorts of technologies are certainly the ones where there is still room for technology improvement. But then again, if we think about poor economies, the smaller scale we go the less society have a role in paying for those. So one of the not so nice scenarios is that then the apartment blocks that have rich people living in them, so they have the money to invest in these smaller scale water treatment facilities. But that would still leave the poorest without any descent water supply". Further, Timonen mentioned, that "it is not Kemira's responsibility at all to solve the water crisis of the developing countries. We can of course help with our technology, chemistry and expertize, but it is not our responsibility to solve those topics".

In the end, Timonen has decided to give her opinion on the situation on the whole. "In Finland we have a lot of this thinking somehow so that we as Finns go now and solve somebody else's water crisis. And I think that it is not realistic. It's not like we can take our own way of doing things and then just import that to some country. It's not the way things are done. So you really need to go down there to understand who are the players, who are the decision makers, could we find some innovative way to bring in the funding, how should we organize this in the best way so it works in the local context, how can we set up the regulatory framework so it supports the (development) and creates the business drivers. It's really the systematic thinking that you should be able to apply in these cases and not the technology. 'We will import the technology and that's it' is not going to work. The truth is that you need to build the whole ecosystem".

4.2.2 Outotec case

Following below information has been acquired through personal discussion with the Pekka Natri, Outotec's Director of industrial water treatment, and from secondary data handed along the conversation, on December, 2015.

Mainly, Outotec is providing solutions for metal and mineral processes, so most of its business projects somehow related to that area, and the target is typically mining sector and various mining industries including metal refining. Also, Outotec produces alternative energy sources, creating waste-to-energy sources by utilizing sludge from the wastewater treatment. In addition, the company has a separate unit which is working for drinking water. Mr. Natri says, "that is

something what we have done during last 15 years in Sri Lanka with population fitting under the term BoP. As it happens, so far the Sri Lanka republic's market is the only BoP market we have been dealing with, and the project in Sri Lanka has begun to evolve 14 years ago. Actually, this project has only become real due to the fact that we managed to organize the export credits from Australia's and New Zeland's agencies (ECA). This governmental agency has audited Outotec in order to provide financing help to the Sri Lanka population who had appealed to Outotec for an assistance in drinking water technology project. Phase 1 was launched after affirmation of ECA to support the project. First credit was given to the enterprise. The quality of Sri Lanka surface waters has been evaluated by UN and reported as containing dangerous contaminants. Consumption of such untreated water was causing dramatically increasing amount of kidney diseases. So, we have created a whole drinking water system for one province with the challenging environment in Sri Lanka, including installing of water treatment facilities and building of distribution units and water towers. Now, we are already finalizing phase 3 at the moment. Switching from one phase to another means making it to a bigger scale. Thus, phases 2 and 3 of the project have encompassed geographically bigger areas within Sri Lanka." As one of the most challenging part in the project plan in the opinion of Mr. Natri, was called the absence of vital infrastructure, thus, the whole project management was difficult due to it. For example, "to build pipelines to a slum areas you need to be creative".

This turnkey project has eventually provided over 450 thousands inhabitants of Sri Lanka with safe drinking water. Outotec has been involved in collaborative work with the Sri Lanka's National Water Supply & Drainage Board (NWS&DB) during best part of the operation, including initial feasibility stages, test work and process selection. Practically, every detail in the project was covered by the company's engineering and project management, such as procurement, construction and commissioning, covering raw water intake, water treatment plant, pipelines, storage structures and pump stations. Besides difficulties in the finance organization of the project and complex coordination owing to large, remote area of implementation, specific challenges were brought by the availability of local skilled workforce, cultural and language barriers, and great geographical distances. Plus the extra troubles were defied by unprotected water source widely affected by algae. Nevertheless, all the challenges were faced and duly dealt with by the Outotec and the authorities of the Sri Lanka. What is important, for the wide range of project operations local engineers was engaged, preliminarily well-trained by the Outotec's training programs. These programs were composed of both classroom-based theory teaching and hands-on site demonstrations for the locals. Also, Outotec has issued comprehensive operation and maintenance manuals for all sites. (Outotec 2015a)

Figure 16: Drinking water plant in Sri Lanka (Outotec 2015a)

Mr. Natri emphasized that the Sri Lanka project was the only one enterprise for delivering drinking water performed by their company in the BoP market. And reportedly, it is a very good example of working with the BoP customer because they have not left any due payments and for 15 years have been paying accordingly to the schedule. In addition, what is relevant to note, by the Pekka's words, the price of the project implemented in the Sri Lanka did not differ much from the similar projects in a developed country. Basically, the underlying reason is that majority of equipment and installation parts have been delivered from the Australia's Outotec plant and Europe, and only pipelines and water towers were made locally. It was said that obviously, while endeavoring to carry out a project of treatment and delivering safe drinking water to a customer, one should not talk about minimizing the costs of the project because it is a question of health, and "you cannot make a little bit cleaned water". Then, Pekka claimed that "it is a little bit like opportunistic business in the sense that we need to find certain kind of place, where a credit supplier would be willing to finance a project. Indeed, we are not going out there trying to promote our products, this is much more targeting. And in order to be able to launch an enterprise, we have to discuss a number of matters with the parliament, sometimes even a president and other authorities. And finally, when they all have signed various kind of certificates, we bring these along to the credit providers to convince them to cooperate and support undeveloped countries". In fact, a company like Outotec has to communicate with both customer and an ECA and put them together providing detailed plans and costs of desirable collaboration with the customer to the agency. However, Pekka notices, that "the main purpose of the ECA cooperation would be an idea of supporting their own countries' industries, promoting export from the country, and aiding developing populations would be only a secondary reason."

Pointing out that Outotec's main business is about industrial water treatment, including waste water treatment, Pekka has told that the company make business with developing countries also undertaking projects related to mining industry. For instance, recently they have been offered to draw up a project to Mexico where is a need to turn municipal waste water as a process water to an industry. So far, Outotec is negotiating this proposal with the Mexican partner. It was pointed out that Outotec does not work with municipals in the developing countries and basically its business strategy goes along the private sector: "we are not really making services for common people, we are working for companies". Mr. Natri has also shared his personal opinion concerning the problem of water pollution in the third world by international companies. Surprisingly, he claimed that nowadays giant transnational corporations are responsible ones, and even if local environmental legislations do not meet proper levels of environmental protection, still, MNCs have their own corporate limits. For example, even though there would be no law which obliges to remove arsenic from the used by company water, the company would still do it. Mr. Natri has also asserted that typically, the most problematic operators are the local companies which often work illegally and do not care about the environment. And "they are the worst", he said. The big corporations, by contrast, are very careful with their publicity, they may undertake some studies which would show how much the public environmental concerns influence on their profit rates if there are negative views put forward their activities. "Of course, the big companies, they have done bad things in the past, but nowadays (last 10 years) they are much more careful about their reputation."

Mr. Natri has shed some light on the matter of fact that in comparison with the world's EC agencies who find it reasonable to support developing countries by making available the funds for the essential collaboration between foreign water companies and developing regions, the Finnish government which is in turn controls ECAs of Finland, is currently saving on such enterprises and cutting the support, though it used to practise it. Nevertheless, Finnish water companies including Outotec along with the Finnish water forum is trying to lobby parliament for the resumption of these practices. And so, their attempts might not be empty leading to a good result of a likely opportunity that next year there is going to be some support in the form of soft loans with the low interest rates allowed to be lent to other countries. Though the target area of such support is not yet decided. Anyways, these loans are meant to be given to an end customer of a Finnish company whom it has business with. That seems to be an attractive option for the BoP customers, notices Pekka.

"We are, first of all, a company, and we cannot make this kind of aid to the developing world. But of course, we are taking part in it, and have developed many new technologies which can improve situation in the developing countries by using less energy and creating less waste. Then, of course,

we are selling (emphasized) those, we are not giving those, so we need to make a money, that is unfortunate fact." And as for technology transfer which is somehow business of governmental sector and it is about municipal water treatment which we do not deal with. Also, he noticed that the company does not work with the small scale projects like delivering safe water to a village saying that "small village is not buying this kind of plants we build", because we are working in a different level. Though, the company might see a potential in delivering drinking water technologies in smaller scale. For example, Outotec has had discussions in Vietnam with various ministries about promotion of company's offerings to help local villages. In fact, now those ministries along with the governmental sector have to decide whether they need these kind of drinking water projects or not. So, we can offer an available project and we can also recommend an ECA for them so they could get a credit from the government. In fact, this is a best kind of aid to these poor countries what we can offer. Pekka has emphasized that for industrializing countries the strategy of carrying out projects in collaboration with the ECAs should be more and more supported by European companies which can take part in these operations. Thus, European commercial business can make profit for themselves dealing with the customers of developing world and at the same time assist the poor to earn better life. Besides that, there is a problem, Pekka said. "If you just give it for free, they might not understand the value of it. But now, for instance, when we are building it together like in Sri Lanka we have taken 50 local engineers, and we have allocated them to run the system. And now they are really proud of the system build". In this case locals have learned to appreciate the results of the job they took participation in. "They want to keep it running first class because they have done a lot of hard work for it." Hence, it was the conclusion of Mr. Natri, he thinks that exactly this kind of support should be given to the developing countries. Regarding the question of advantages the company gains having business with the poor, Pekka answered that first and foremost is making a profit with every project. So, they would not sacrifice that in any case.

Talking about technological transfer, Mr. Natri shared his company's views that basically technology is where their money come from. So, they would not simply give it away free of charge. That is why the company has license fee systems which allow to sell a license to some other company to be able to operate with Outotec's technology strictly in their own site. This is a model of avoiding IPR (intellectual property right) problems.

Concluding, Pekka has emphasized again about importance of raising soft loans by governments of affluent countries to the developing ones. It will lead to the win-win situation for both. The thing is that if government supports an interest rate, the end customers usually always pay back. Another thing here is that a bank can lack trust to some company in Africa, but when it goes through the governmental loaning system, paying off can be guaranteed. In addition, when a

government provides, for example, some amount of finances in form of soft loans to a company in its water management sector, then the development of the sector is secured and distribution of safe water is under control in comparison with what may happen in private sector entrepreneurship. In essence, it is really good way to have business with the BoP customers. European countries like Finland can 'teach' them the right way of sustainable development, while the BoP customers not only learn to be responsible making business with the foreign companies but also learn to take care of the property they are paying bit by bit for.

4.2.3 Fenno Water case

Following data has been obtained through personal discussion with the Timo Marjomäki, Managing Director of Fenno Water Ltd Oy, on December, 2015.

Mr. Marjomäki shared relevant news that currently their company is trying to access the Indian and Chinese markets with their water purification technologies. In India, for example, Fenno Water (FW) is attempting to sell more modern processing water technology to communal wastewater treatment plants than they have there so far. Offered by FW technology would include removal of biological phosphorous and nitrogen contaminants in the municipal waters which is an essential addition to the existing treatment of water in India. However, Indian water market is very large and competitive according to Mr. Marjomäki. Thus, the competition is going on, and which company will be given preference to is yet to be decided by Indian side. Timo says that FW has to compete with the local companies some of which, in fact, are owned by Holland. Nowadays Indian market of water treatment processes has already enough existing contractors and suppliers in opinion of Mr. Marjomäki. So, to enter the market FW must overcome a number of barriers. And it is not mainly about what kind of technology will be chosen by the Indian party. Certainly, money play one of the prime roles in the decision-making by the Indian side. What is also important, a company like FW is demanded to conclude a PPP (private public partnership) contract, which brings difficulties for the FW because in this case company has to "sell an equipment without getting money". The payment would be arranged later, indeed, but this situation is not really suitable for FW. Thus, it is the main difficulty in the competition for FW. "It is a question of too big money to invest. And we have barely entered this country's market. The risk seems to be too high to run."

As for the management of water equipment by the locals in India, Mr. Marjomäki claims that Indian people are enough educated. Moreover, he is surprised that they have quite high knowledge

about the technology offered by FW. For instance, Timo noticed that local engineers possess a much better educational skills than water treatment plant workers in Kazakhstan, another developing country where FW has had several years of projects implementation experience. Regarding this experience, Mr. Marjomäki shares the evidence that difficulties appear also during the first year of using the water treatment plant which FW has participated to build in the North Kazakhstan. “They needed a lot of our help”, Timo claimed. “People cannot learn from the paper, they ask us about how to do everything at the plant”. Timo assumed that perhaps, the local engineers just do not read the manuals or lack educational background to understand them. Thus, FW’s employees have to make frequent visits to the place and check if plant’s equipment works properly. This state of things does not bring troubles if the contract includes stages of maintenance from the beginning. Mr. Marjomäki calls it ‘aftermarketing’. Timo emphasizes that in the first place FW is trying to develop not too complicated technologies for the developing countries use. So, plant would “work according to logic”. “We try to not put too many instruments in the equipment”. For example, Russian engineers which Timo works a lot with, they equip their technologies with plenty instruments, measurement devices. “And everything depends upon those. If something goes wrong with them, then a whole system can shut down.” Of course, internationally these technologies must follow to the minimum instrumentation standards, mentions Timo. Hence, “we cannot sell too simple technology to a country, because the authors of the technologies do not accept such possible simplifications”. “Everything what we design goes to the state expertize, where they examine it for compliance to the proper level of instrumentation which should be approved by the state and accepted by the author of the technology. This is quite exact procedure”.

Mr. Marjomäki has also shared an experience of FW bringing to the Kazakhstan and Russian markets a new bioreactor technology with the tanks designed in the different shape than local equipment of old style. “It took several years for the new technology to be finally pushed by FW to those markets because people were against it. Perhaps, it is safe to make technologies like earlier”, Timo suggested. The other problem of technology transfer to the developing country lies in the fact that people of different cultures have different state of minds and understanding. They come from various Universities with the different levels of education and participate in the discussion, taking part in the decisions either client accepts the technology or not. In addition, these people also tend to desire to keep thing how they have been earlier. Moreover, locals might think that their own existing technologies are good enough and sometimes they do not wish to consider other possibilities. However, Timo explains that in a situation when a population does not have its own water treatment technology, for example, in Africa, when FW has tried to realize a chance of cooperation, “there was no understanding of what kind of technology is needed and

what kind of plants must be built." Timo said that "indeed, African inhabitants need a good technology like what FW would offer, but in fact, locals did not even know there was a water technology market where they could choose the most suitable one, and they did not have any experience in understanding the differences and choosing the right one. There were companies selling very old bad (in the opinion of Mr. Marjomäki) technologies for cheap. They just wanted to make money and go back home. These unprincipled companies were offering 30-50 years old water technologies in the developing country like Africa. Obviously, modern sustainable Finnish technologies have no chance to compete with such in costs of implementation. For instance, some companies from Holland have been selling in Africa at a very low prices water plants which Holland has been using few decades ago, and nowadays selling those to unindustrialized countries makes big profit". Timo said that he has seen quite often such cases of marketing in the developing countries. The other problem of working with the client in developing country, as Timo sees, consists in the idea that "local people do not wish to think about future advantages what may a new water technology bring if they invest in it in the beginning." But the worst thing according to Mr. Marjomäki, is that those companies who sell old technologies to the poor, are financially supported by the governments of developed countries like Germany and Holland. "If the money are coming from certain places, companies will be sure to win the market with their old technologies, no matter how unsuitable or unsustainable they appear for the developing regions". Timo admits that he is very surprised that countries like Germany and Holland invest in such ambiguous enterprises. Unfortunately, Finland has stopped governmental support of developing nations because nowadays all the financial aid flows through the European Union (EU). As for the technologies of FW with which the company tries to enter the market of developing countries, they are absolutely new and sustainable, and do not differ from the ones used in industrialized countries. Concerning the possible reduction in the costs of the water treatment plant built by FW, Mr. Marjomäki notices that climate plays important role. "At the South we can make different kind of buildings for the plant, not so expensive as at the North. Also, we can reduce amount of process lines. It's cheaper to build if you make bigger lines", though the standards of quality regulations still should be conformed with. However, of course, there are differences in the standards among the countries, and these difficulties can impact in the increase or decrease of the total price of the plant." In addition, Timo has noticed that since biological processes flow faster in the warm temperatures, the water treatment is easier to carry out in the developing countries as commonly warm ones.

FW does not usually build infrastructure for the technological machinery it sells, however the company designs comprehensive projects and draws all the essential dimensions for their equipment to be installed properly, but the construction itself usually is made by local designers.

And FW always works closely together with them. “For our technology to be utilized in a developing country, there should be infrastructure available like pipe- and switch lines. It is one problem. For example, two times we have built a plant without the pipe systems fixed up. So, plant is staying there for a year or more and is awaiting for the essential infrastructure to be built. Same goes with the provision of electric power. In a developing country we have had similar problems of a new built water plant which had to wait for the electricity supply to be launched. There were cables, but no energy available.”

To conclude, Timo emphasized that it is mostly the question about money. If a safe water delivery project in a developing country gets supported by an investor, so there would be no big risks for a company like FW to have business with them, the cooperation is favored. “We only go there when we know for sure there are money for our job to be done. We do not have people to check all the investments, funds and financial examinations. FW offers its services only when a project is ready, either it is in a developed or developing country.” Also, in some cases in unindustrialized country FW had a difficulty to sign a contract directly with the client who needed a water treatment equipment to be build, so FW had to search for a local water delivery company in order to become subcontractor for it. To keep within the law only a local company is able to make a contract with the city to carry out a water delivery project. For instance, in India and in Kazakhstan we have to collaborate with the local building companies, so those companies become contractors with the clients FW sells its water treatment equipment for.”

Mr. Marjomäki has added that the municipal water delivery or waste water treatment projects always depend on local political decisions within the developing country.

5 CONCLUSIONS

There is an urgent necessity to address the water crisis in the developing countries. Countless amount of lives are at stake. In our world wherein progress in various spheres is aspiring at a booming rate, humankind must tailor its technology to deal with such tragical problem. The first and foremost task is to prevent the waste of human lives by taking radical measures and applying crucial solutions as soon as possible. Since the struggle for survival will cease to be the sense of life for billions, the path to progress in the developing world will be unblocked. This progress will clear the way to prosperity, economical independency, increasing standard of living and sustainable development.

Current research has been done for the sake of BoP population which desperately needs to obtain an adequate access to safe water sources. First of all, it came across highly reasonable to explore deeply the range of water problem's causes and its impacts. Then, various kinds of the most essential and suitable solutions have been thoroughly discussed. Among the reasons the following were featured. High rate of population growth, internal migration and change of human behavior were found to be some of the most plausible grounds for creating quantitative and qualitative water problems. Besides, there is a deficit of investments in water sector and the upper limit imposed by the scarcity of water sources. Political and military instability and poverty in the developing countries are considered to be the context of these interrelated reasons of water issues. Corruption and misuse of water resources, which cause poor planning and unsatisfactory implementation of water supply projects, scare away potential investments in the water sector. Also, climate change and global warming threaten fresh water security in the world, particularly in the developing countries. Poor governance, which is unable to manage with the water security and its either temporary or long-term unfavorable consequences, weak incentives, bad institutions and bad allocation of resources were blamed as some of the prime reasons of water problems. High political risks, instability of regulative practices and unprofessional conduct of authorities result in governance's inability for appointing investments straightly to the sustainable water projects, and to source attracted financing where it is intended. In fact, to date, problems in water sector seldom become one of a political priority in the developing world. Dominance of the current economic growth in the developing nations makes authorities to shut their eyes to the acute danger placed upon environment, especially, precious water resource. Advancement in the economic sector is highly prioritized over environmental sustainability. While natural resources are being excessively exploited to create revenues, subsequent environmental degradation aggravates living conditions of millions and what is critical, deprives populations of safe drinking water. What's worse,

deterioration of the freshwater ecosystems is caused by uncontrolled discharge of untreated wastewater flows. And the number one polluter of the water sources around the world is the animal agriculture which is simply the most unreasonably ignored cause of the water crisis. Current research scrupulously elucidated this matter. One of the most enlightening facts has revealed that animal agriculture produce contributes to roughly 27% of total water footprint created by humanity. It was shown that if the world draws attention to the indisputable connection between availability and cleanliness of fresh waters and the animal agriculture which inflicts absolutely irrational losses to it, there would be far less necessity of solving the world water crisis in emergency pace, especially in the developing countries where industrialized world hugely participates in the creation of water footprint by growing and exporting livestock and agricultural products.

Given the complexity of the water crisis brought by so many interconnected causes, a range of strongly supported viable solutions were suggested in this paper. Besides, existing programmes, guidelines, reports and other projects realized by involved in the water solving issues parties operating for the sake of developing populations, were evaluated and reviewed.

The role of environmental education in the developing world cannot be overestimated, especially in regard to the values and dangers of water. Delivery of environmental information to populations contributes to the knowledgeable and rational management of available natural resources. Thus, environmental ignorance of authorities as well as individuals should be liquidated. What is important, is that the education can be spread by the help of international organizations or any other institutions acting in the area of environmental problems, or it can be done in form of continual social marketing by the business companies.

It was particularly argued in the research that remarkable improvements in water usage can be brought by significant water savings in the agricultural department. Diet is one of the biggest factors in wasteful personal water usage, which could be largely diminished by more intelligent dietary choices. Abandoning animal agriculture practices and changing to the plant based diet would bring indispensable advantages in water availability and water quality preservation, let alone entire ecosystem.

Another solution to the water issues sounds quite obvious. In order to make plans for investments in the water sector of low-income countries with possible international support, there is an urgent need for political and military stability, as well as for elimination of corruption.

In the developing world wastewater treatment so far is not on the agenda at the political discussions because there are more emergent issues to solve, and delivering drinking water is regarded as a priority. However, it is obvious that instead of searching for solutions to deliver safe water from the increasingly polluted sources it is absolutely rational to not contaminate them in the first place. That is why waste water treatment should be certainly given credit for in the rapidly industrializing world. Today, particularly unindustrialized countries have to appeal to advanced technologies and treatment methods on the way to rational and sustainable resource utilization.

Making the water supply ubiquitous and available for all appears to be a long-term objective. Therefore, it is truly sensible to reorient the focus of water governmental policies towards the most suitable and viable options for the developing populations. Thus, attempts to extent centralized water networks should be discontinued as not executable in a big scale for all excluded from the service, especially in rural areas, because implementation of such time-intensive centralized options will leave immense amount of individuals with no survival instrument for indefinitely long period of time. Moreover, the quality of piped water in low-income countries is often far from adequate due to dissatisfactory infrastructure. Reasoning in terms of sustainable development it should be admitted that various point-of-use water supply and treatment systems appear to be more affordable for the poor households and, what is important, environmentally sustainable. Avoiding the necessity of creating expensive distribution infrastructure, especially in rural areas, as well as eluding high municipal pipe leakage rates, communities can directly apply various decentralized options, self-sustaining low-cost community scale-systems and point-of-use technologies and products to generate essential amounts of clean water, while averting impacts on the environment.

Inadequate management of water resources by governments of developing countries underlies deficiency and unequal distribution of available water resources among the population. In spite of the fact that governments have an ownership of water assets, and in a number of circumstances completely control its administration, the record of its beneficial work is very poor. Due to irrational water management policies in the developing world, subsidies for water use hitherto have been basically supporting the wealthier inhabitants, unfairly avoiding the poorest which had to pay penalty prices for commonly unreliable service. This situation must be changed straightly from the political level. And private sector together with NGOs and MNCs may come forward as a guiding hand in assisting such changes by active operation in the BoP water market delivering safe water to the poor. However, operating at the BoP market water companies should not solely aim for the profit and offer some unreliable products to those who do not have an alternative. If an enterprise strives to make business in a developing nation, its projects have to conform fully to the

sustainability issues. Companies should be very mindful of instituting technological innovations in the BoP sector because working with the poor is not an easy task as it was thoroughly discussed in the research. But there are ways which hold strong potentials and advantages for both, water delivery enterprises and BoP consumers. Technologies and products which are needed by the poor must be affordable, sustainable and of an appropriate quality. These alternatives should be brought not only by domestic public interventions of the low-income communities but also by the foreign companies which are ready to enter the large market of few billions of consumers and knowingly implement the technology transfer of suitable solutions. The BoP water market is broadly open for technological innovation, and the clear advantage in this area is the unique opportunity to omit many kinds of environmental mistakes made by developed countries on the way of their growth. Furthermore, the development and market of clean water technologies in the BoP sector should be carried out with the serious aid of governments, while various enterprises of water products and technologies for the poor should seek this cooperation from them, which will benefit both.

Current research has also included examination and comparison of various water purification technologies and products which nowadays exist on the BoP market. Special consideration has been given to the aspect of clean water technologies for the poor in relation to sustainable development.

The question of technology transfer was comprehensively discussed with pointing out main hindrances on the way of its implementation between the developed and developing world. The means to overcome these obstacles were properly observed as well.

To explore to some extent the possibility of technology transfer from Finland to the BoP sector, 3 case studies have been implemented. Results of the conducted interviews can be found in the latter part of the research.

It is in our power to share the knowledge and the technology to ease the burden of severe third world conditions. Environmentally oriented clean water technologies are some of the prime tools in the course of meeting the essential needs sustainably.

Humanity ought to figure out sustainable and equitable course of sharing world water resources, where the incentives to meet people’s needs and to conserve nature’s capital, lie together on equal terms. It is sensibly to aim for economic development merely after the mentioned two objectives are fulfilled all over the world. However, the development in any aspect is favorable as an engine for addressing and supporting execution of basic human’s needs, after all it will offer an opportunity to unveil man’s potential, providing him with health and time at disposal. Disastrously, the way humankind dwells nowadays is too far from this course.

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ANNEXES

Annex 1

Discussion Guide

1. With your current developed water purification and/or water cleaning technologies, which one or which are:

    a) present in the market in the developing countries or in the Base of the Pyramid (BoP) markets?
    b) (if none yet), which water technology do you think has the promise in the BoP markets?

2. How do you see this (these) water purification technology(-ies) in the BoP markets in terms of:

    a) affordability (of the BoP people/consumers)
    b) profitability (for the company)
    c) technical feasibility
    d) technology transfer and business model
    e) benefits/sustainability benefits (economic, environmental, and social)

3. What problems/barriers accompany in transferring/selling these technologies to the BoP markets in the developing countries?

4. What are prerequisites for the BoP consumers to be able to use your technology?

    (Would your company consider an idea of collaboration with the potential consumers in the developing nations in order to co-create a water technology product or adapt existing at your company solution in relation to specific needs of the poor?)

Annex 2

Questionnaire

5. **With your current developed water purification and/or water cleaning technologies, which one or which are:**

   c) present in the market in the developing countries or in the Base of the Pyramid (BoP) markets?

   d) (if none yet), which water technology do you think has the promise in the BoP markets?
   - can you give examples from experiences of other companies? (if none of own exist)

6. **How do you see this (these) water purification technology(-ies) in the BoP markets in terms of:**

   f) affordability (of the BoP people/consumers)

   g) profitability (for the company)
   - What advantages or profits does your company gain having business with poor?
   - What opinion you have on making business with developing countries?
   - What is your company's view on the low profit margins that sales would have in 3rd world country?

   h) technical feasibility
   - How manageable is the maintenance for the transferred products among the unskilled villagers?
   -

   i) technology transfer and business model
   - What does it take? (to implement technology transfer)
   - If your company still is not in the business with the poor, do have existing plans, contacts or chain of supply for advancing into BoP sector? Are there any incentives for your company to spread into BoP markets? (or what are your current motives in having business with the BoP)
   - What could be more reliable choice, working with governments of developing countries or with its private sector?
   - Do any subsidies exist to aid the technology transfer into 3rd world markets? (Any supportive measures from governments, international agencies, and non-governmental organizations (NGOs)?)

   j) benefits/sustainability benefits (economic, environmental, and social)
   - Is your technology sustainable? Could you explain why?

7. **What problems/barriers accompany in transferring/selling these technologies to the BoP markets in the developing countries?**
8. **What are prerequisites for the BoP consumers to be able to use your technology?**

9. Would your company consider an idea of collaboration with the potential consumers in the developing nations in order to co-create a water technology product or adapt existing at your company solution in relation to specific needs of the poor?

10. What are the material costs in producing your cleaning water technologies?

    - What are the main factors in the production of these technologies that raise the price of the end product?
    - What can reduce the price of a technology during its production? Are there redundant parts of a product that are not essential for survival and which can be eliminated to reduce price as much as possible? Is it possible to streamline the production at your company's factory?

11. Are there problems of utilizing your technologies in different than northern climate? What are these technical performance issues? (operating temperature range, effects of humidity, effects of airborne and waterborne dust and particles, effects of 3rd world water on products' longevity, adaptation to different kinds of pollutants, inability to filter particular southern pathogens..)

8. What is the functioning principle of the technology which is driven to BoP markets?

    - What is the smallest scale purification unit you have?

9. How applicable is the technology in challenging conditions of developing regions?

    - What are the system and infrastructure requirements? Is it applicable in rural areas where no electricity available?

10. What would you highlight as the most important aspects of a possible technological solution to solve the water crisis in developing world?

Annex 3. Appropriate disinfection technologies: cost and appropriateness summary (Burch and Thomas 1998)

Variables/technologies	Production	First cost	Capacity cost	Life cycle cost	Effectiveness[†]			Convenience[‡]		
Units or subcategories	l/day	$	$\$/m^3/day$	$¢/m^3$	Res[¶]	B/v[§]	P/w[#]	Sup[††]	Hi[‡‡]	Lo[¶¶]
Chlorine dose + roughing filter	24000	2400	100	6	***	***	**		*	*
Slow sand + roughing filter	24000	2160	90	3		**	***	***	***	*
UV + PV (8 h) + filter	7200	2366	329	14		***	**	*	*	**
Chlorine batch	200	0	0	9	**	***	*		***	**
Household filter	60	20	333	85		*	**	***	***	**
Home UV + PV[§§] + filter	500	381	761	63		***	**	*	*	*
Sol-UV[##]/batch bottles	14	1	43	133		*		***	***	**
Water boiling (purchased fuel)	20	0	0	2083		***	***		***	**
Batch solar: existing 1 m^2	23	78	3425	235		***	***	***	**	***
Flow-thru solar: existing 3 m^2	570	2145	3764	144		***	***	***	***	**
Solar: potential polymer 1 m^2	304	84	276	19		***	***	***	***	**

[†] Effectiveness scales: high = ***, medium = **, low = *, none = blank (more stars = more effective).
[‡] Convenience scales: no need = ***, low = **, medium = *, high = blank (more stars = more convenient).
[¶] Res = residual disinfection ability.
[§] B/v = effectiveness against bacteria and viruses.
[#] P/w = effectiveness against protozoa and worms.
[††] Sup = need for supplies.
[‡‡] Hi = need for high-skilled labor.
[¶¶] Lo = need for low-skilled labor.
[§§] PV = photovoltaics.
[##] Sol-UV = solar UV.