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A Total Evaluation of Potential and Available Water Ecosystem Services in Balance with Social and Technical Systems

Master's Thesis in the International Master's Programme Applied Environmental Measurement Techniques

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CHALMERS UNIVERSITY OF TECHNOLOGY
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ABSTRACT

This study employed a choice modelling (CM) in the pilot survey to analyse consumer's preferences and willingness to pay (WTP) from a set of choices. Water ecosystem services were evaluated specifically considering the willingness to pay for the sustainability of the ecosystem from provision and supply of drinking water from tap water or bottled water. In line with the supply of this ecosystem services, it thus, affects the social and technical system such as leaking of pipes during water delivery. In as much as the consumers are aware of these effects, they are willing to pay for maintenance of the leaking pipes, ready to accept the effect of changes in policies due to the sustainability of the ecosystem services and consequently readily to accept investment for future generation.

It is pertinent to note that the use of water as recreational activities such as learning purposes, swimming, fishing and sailing cannot be compromised by the people (water users). Therefore, further regulation is required for sewer overflows and other pollution effects on water ecosystems. In this pilot survey, it was assumed if consumers will be willing to pay 10Kr/m^3 for investing in water as an ecosystem service, and the general response was that they are willing to pay up to 100% increase in the fee, that is an average of 20Kr/m^3. This indicates the value attributed to water ecosystem service.

From the overall analysis, it can be concluded that individual income of consumer(s) tends to influence willingness to pay positively and significantly for provision of a sustainable water ecosystem services.

Keywords: ecosystem services, sustainable development, millennium development goal, choice modelling, willingness to pay,

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ABBREVIATION

ATP	Affordability to pay
CM	Choice modelling
CRC	Cooperative Research Centre for Water Quality and Treatment
CV	Contingent valuation
CVM	Contingent valuation model
DB	Double- bounded
DC	Dichotomous choice
DBDC	Double- bounded dichotomous choice
GDP	Gross domestic product
EU	European Union
IWSA	International Service Water Association
MEA	Millennium Ecosystem Assessment
OECD	Organization for Economic Co-operation and Development
OFWAT	Office of Water Services
SB	Single-bounded
SEPA	The Swedish Environmental protection Agency
SBDC	Single – bounded dichotomous choice
UN	United Nations
UNESCO	United Nations Educational, Scientific and Cultural Organization
USGS	United States Geological Survey
WTP	Willingness -to-pay

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1. INTRODUCTION

1.1 Background

Water is an inevitable substance that is used in everyday activities. It is a precious resource that needs to be handled and use with utmost care. The major water usage categories are domestic, commercial, industrial, thermoelectric power and public use and losses. Population growth and economic activities have great influence on the usage of available water. A not well- structured economic and technical development could contribute to destruction of water- related ecosystems with unfavourable consequences for water resources. The wise use of water- related ecosystems with respect to the environmental services it provides is fundamental to a sustainable cost – effective alternative to infrastructure development. For an efficient evaluation of water ecosystem services, the need to embrace sustainable development is vital. Sustainable development is defined as "*development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs"* according to the Brundtland Commission's report *Our Common Future* in 1987. Water plays an important role in the existence of the nature. It is a limited entity that is limited on the surface of the earth. Water is released or evolved into the earth surface in different forms. It can go through evaporation, transpiration, condensation, precipitation and collection. Water is a sustainable commodity that aids the continuity of many ecosystem services. Agriculture relies heavily on water such that it is the major consumer of water. One fifth of the people living in the cities and three quarters of the rural populace in the developing nations lacks access to safe supplies of water, as their counterparts in the developed nations suffer seriously from problem of water scarcity, pollution and wasteful use
(Lundin et al, 2003).

The importance of water in the ecosystem services cannot be underestimated. It is imperative to consider the value of water with respect to its demand and needs for numerous activities. The effect of this ecosystem service needs to be evaluated in balance with social and technical systems. The economic evaluation of this ecosystem services is an effective way to understand its multiple benefits (Jing Li et.al, 2006). Ecosystems can only be managed sustainably with a proper understanding of how these services they provide are impacted by human activities.

On the other hand, for an accurate economic accountability of anthropogenic activities on the environment as regards ecological impacts is to estimate the monetary value of reducing those impacts or preventing these impacts from occurring using surrogate market techniques, such as determination of prices of goods with different measurable characteristics through regression analysis, travel cost and non- market valuation methods (Prato, 1998).

Ecosystem valuation can be complex to analyse. The rising protection and management of natural resources can make it difficult to implement the restricted and limited budgets. There should be equilibrium with the economic decisions,

societal values, and support from the public with a benefit to the natural environment and justifiable accountability. The willingness to pay for ecosystems services is rather independent of whether ecosystems services are luxurious or not, there are various issues on sets of income group in a particular place that are readily willing to pay for an increased provision of ecosystems services.

1.2. Aims and Objective

The aim of this study is to provide development paths for evaluation of available water ecosystem services for the social and technical systems to meet the following:

- Estimation of water in a non-market value perspective
- To evaluate customers' willingness to pay as regards preferences for water consumption
- To motivate a higher level of investment in the social and technical systems
- To evaluate the willingness to pay for sustainability of water ecosystem services.

1.3. Literature Review

1.3.1. Water usage

Water usage and protection is vital in the estimation and evaluation of water ecosystem services. Watersheds, which supplies and purifies fresh water has been under protected. A global analysis of about 106 primary watersheds discovered that up in one-third of these sheds, more than half the land area had been cultivated for agricultural purposes or for urban – industrial uses (Postel, et al., 2005). Valuation of wetlands is not limited to economic benefits to humans alone, but also, its benefits to nature (Lambert, 2003). More than 90% of the forestlands have been converted to other uses in the Indus basin, Senegal and Lake Chad basins in the Sub- Saharan region of Africa. Some parts of China's Yangtze and the Yellow River basins have lost 85% and 78% of their forest cover, respectively (Brown, 2001).

In Japan, at the Water Resources Research Centre, DPRI, Kyoto, a field survey on the estimation of land use and water usage in the Huaihe river basin was analysed using a satellite. It was discovered that there was an accumulated value of water budget components (rainfall, runoff and evapotranspiration) in the downstream region of a catchments area of about 2.525 thousand km^2 .The accumulated rainfall in this region for 123 days was 738mm, runoff and irrigation was 238.2mm and 84.7mm respectively and evapotranspiration was 408.9mm (Kozan et al., 2004). (Zhang, 2002) concluded that; the unavoidable rising prices of water is a reflection of the changes in the leadership and governance from communist to a market based socialist principles. There has been a shortage in supply in water in some area of the world such as China, where annual demand for water is 4.5 billion cubic meters in a year while supply is about 4.2 billion cubic meters. This gives a current annual deficit of about 0.3 billion cubic meters (Hou and Hunter, 1998). In Shanghai, water is mostly used in three sectors namely; household,

agriculture and industrial. In 1990, agricultural operations make use of 51.5% of the total annual water supply needed in the area
(Hou, 1999).

1.3.2. Estimation of Willingness to pay

The study conducted through estimation of willingness to pay (WTP) and Affordability to pay (ATP) in Iquitos city of Peru shows that WTP was approximately twice of current average payment level and ATP is in the range of 10%-20% lower to 20% higher than the current average payment level. This invariably means that, valuation on the improvement on water and sanitation services is high. On the contrary, the increase in the tariff level for financing project would be small due to the limited payment capacity. In addition, other effective managerial approach of effective collection of revenue should be well managed (Yasuo et al., 2003). It has been noted that public water has been provided at lower cost compared to other public utility services. The provision of water at low cost through subsidies of water projects from government policies as created high- quality water supplies at low cost and the demand of water by the users is not commiserating to the cost of production of quality water (Mann, 1993). On the other hand, it is assumed that households have the ability and willingness to pay for improved services as long as monthly charges for sanitary planning is less than 3% of the of household income, and water supply also should not exceed 5% of the household income (Rogerson, 1996). There have been competitive usages of water ranging from urban, agricultural and environmental uses. Natural disaster such as droughts has a great effect on the supply of water. Therefore it is of great concern to control efficiently the production, supply and distribution of water as a great economic scarce resource. On the contrary, a country such as the United States has experienced rising cost of water due to economic growth and urbanization, which leads to greater water demand. The per capita use of water increased by about 50 % between 1950 and 1985 (Heaney et al., 1990).

1.3.3. Water Control

Across the globe, different methods have been used to control and conserve water. In the municipality of Waterloo in Canada, higher water rates and distribution of water conservation kits and public education has reduced water per capital usage to about 10% within three years. Water saving devices, efficient irrigation, leak detecting and repair has saved some parts of Jerusalem in Israel about 14% drop in per capital usage of water (Postel, 1993).

An individual per year drinks one cubic metre of water. About 100 cubic metres are used for domestic activities and approximately 1000 cubic metres to produce the food he or she needs to eat. Water scarcity, as an indicator is vital in determining the deteriorating state of water supply across boards (Varis, et al., 1997). Table 1 shows different water barrier as regards to its influence on persons per flow unit.

Table (1): Falkenmark's Water Barrier Scale

Well Water Conditions	<100 persons/ flow unit
Mid- European	100-600 persons / flow unit
Water stressed	600-1000 persons/ flow unit
Chronic Scarcity	1000-2000 persons/flow unit
Beyond the Water Barrier	>2000 persons/ flow unit

Source: Falkenmark, M., 1989. The Massive Water Scarcity now Threatening Africa: Why Isn't it Being addressed. In *Ambio*, Vol. 18, No.2.

1.3.4. Water Indicators

In Sweden consumers pay connection fees and operation charges. The connection fee is subsequent to initial cost at the time of investment in new residential, commercial and industrial areas. The connection varies among the municipalities and it is determined by the geographical and market factors such as regional economic, geographical location and climatic factor (Gustafsson, 2001).

Stahre et al, (1995) in their report on "performance benchmarking in six major cities in the Scandinavia", evaluated some performance indicators on long term development of water and wastewater services. The performance indicators are structured in the following groups:

- Customer satisfaction: this indicator evaluates the end results of water supplies and appraisal of the water services from customers' points of view.
- Quality: this evaluates the effects of the economic influence on water production and supplies and the customers' satisfaction.
- Availability: this is a performance indicator that describes the efficiency and reliability of the entire system.
- Environment: this performance indicator is the influence of the services on the entire ecosystem
- Organisation: this describes the services delivery and maintenance relationship between the service provider and the customers
- Economy: this indicator evaluates the entire cost effects and influences on the development of the entire system.

1.4. Ecosystem Services

Ecosystem services quantify the importance of nature as it supports our existence. These services include waste treatment, climate regulation, water regulation, water supply, gas regulation, erosion control and sediment retention, soil formation, nutrient cycling, pollination, biological control, social relation, food production, genetic resources, cultural and recreation (Costanza, et al, 1997). On the other hand, water sustainability is related to some varieties of functions, such as supporting services (nutrient cycling), regulating services (water purification),

provisioning services (fresh water availability, food production), and cultural services (religious, spiritual, aesthetics, cultural heritage etc) (Kulshreshtha, et al., 2002). The direct and indirect service functions primarily to provide for human welfare and these services are linked to another. The essential form of valuation of the ecosystem services is to be able to quantify or value each service monetarily. It is important to note that ecosystem functions and ecosystem services are interrelated and dependent as they support human welfare (Costanza, et al, 1997).

1.5. Ecosystem Functions

There is numerous living and non- living processes that make the ecosystems services work. They are processes that initiate the existence of the ecosystem, this includes: nutrient cycling, primary production and decomposition to mention a few. Ecosystem functions contribute to the well-being of mankind and are important to human civilization, such that its economical value is far larger than the whole global economy (Costanza, et al., 1997). Some times, these functions combine into two or more to form an ecosystem service. On the other hand, ecosystem functions can also act independently. Table (2) shows some ecosystem services and functions that are related to the valuing of water as an ecosystem service.

Table 2. Ecosystem services and functions related to water usage.

Ecosystem Service	**Ecosystem Functions**	**Remarks**
Water regulation	Control and regulation of hydrological flows	Water used for irrigation (agricultural purposes), transportation or industrial uses
Water supply	Reservation and storage of water	Water provision through reservoirs, watersheds and aquifer
Waste water treatment	Recovery of mobile nutrients and removal or breakdown of excess biological nutrients and compounds	Waste treatment, detoxification and pollution control etc.
Climate regulation	Precipitation, transpiration, regulation of global temperature, global warming etc.	Greenhouse gases regulation, control of gases emitted in the marine environment
Biological control	Regulation of population	Control of predator-prey survival
Food production	Production and reproduction of raw material for food	Production of crops, fish, fruits, cooking and processing
Erosion control and sedimentation	Retention of soil in the ecosystem	Prevention of loss by runoff, storage of stilt in lakes and wetland and some removal processes
Recreation	Provision of recreational values	Swimming, sport fishing, eco-tourism and some other outdoor recreational activities
Cultural	Providing opportunities for non-commercial uses	Spiritual, scientific values of ecosystems, artistic and aesthetics
Soil formation	Soil formation processes	Weathering of rocks form agent of denudation such as rainfall, snow

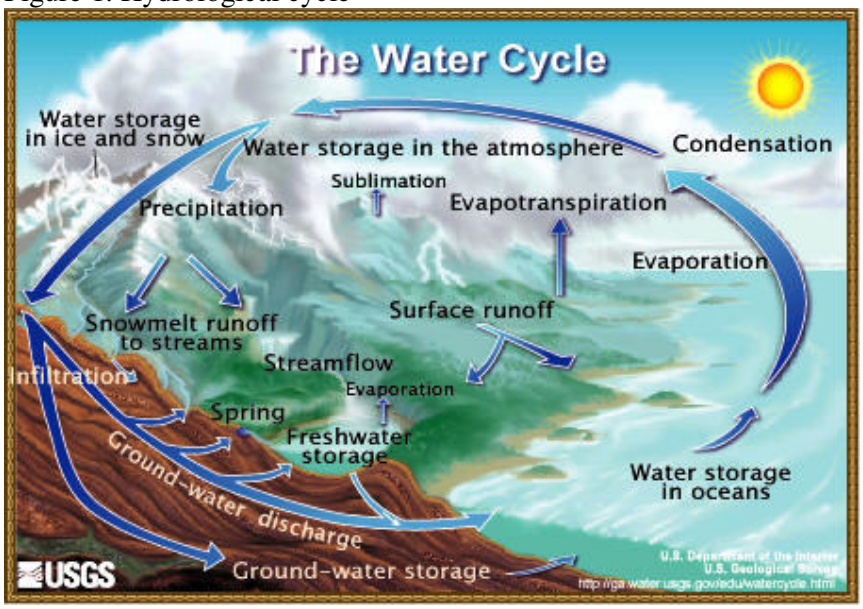
Source: Adapted from Costanza 1997

1.6. Water Cycle

Water on the surface of the earth is always transforming from one form to the other due to changes in temperature (USGS, 2006). The repeated changes make a hydrological cycle. The hydrologic cycle can be initiated with the evaporation of water from the surface of the ocean. The ocean serves as the major storehouse for water on earth. It is estimated to house about 321,000,000mi^3 (1,338,000,000km^3) of the world's water supply of 332,500,000 cubic miles (mi^3) (1,386,000,000 cubic kilometers (km^3)). This storage representing about 96.5% and the oceans generally supplies around 90% of evaporated water that goes into the water cycle (USGS, 2006). The lakes that provide fresh water have not more than 1% of liquid water that is available on earth (Saiejs and van Berkel, 1995). This evaporated water is transformed from liquid to gas phase,

which later condenses to form clouds. The condensation is formed as precipitate such as rain, snow, fog, hail, sleet and graupel; which later returns to the earth surface (Arctic Climatology and Meteorology, 2006). In every year, an average of 505,000 km^3 of water falls as precipitation and 398,000 km^3 of it over the oceans (Dr. Art's Guide to Planet Earth, 2006) Some of the water released back to the surface of the earth, evaporate back to the atmosphere or the water percoslates into the surface as groundwater. Groundwater either seeps its way into the oceans, rivers, and streams, or is released back into the atmosphere through transpiration. The leftover water that remains on the earth's surface is runoff, which consequently empties into streams, lakes, rivers and later carried back in to the larger water bodies, where the cycle starts again.

Figure 1. Hydrological cycle



Source: US Geology Survey

2. ECOSYSTEM SERVICE DRIVERS

The changes in the ecosystem due to natural or human- induced influences directly or indirectly affecting the ecosystem are called the drivers. These effects range from local to global and sometimes long–term. For example, change in climate may be experienced locally or its effect could be witnessed globally. The increase or decrease in population might also have some negative or positive effect on the ecosystem as a whole.

2.1. Direct Drivers to water as an ecosystem service

The direct usage of water has lead to over dependence on this ecosystem service. Some of the important direct drivers are climatic change, overexploitation of water resources and pollution (Kulshreshtha et al., 2002). The sources of values associated to water usage vary depending on the user of the service. For example, water is directly used in industries for general production such as cooling, cleaning processing etc. Also, its usage in the household activities cannot be underestimated. It provides basic utility service such as cooking, washing, cleaning, recreation, sanitary etc. Water is used for powering hydroelectric system, supports fishing activities and provides healthy watershed for aquatic habitation.

Over the years, water as an ecosystem service has been affected by direct activities of man. The freshwater have been altered due to construction of large dams, polluted as a result of excessive nutrient loading causing euthrophication. The water body such as the coastal ecosystem has been distorted by anthropogenic activities such as industrialization (port development, resort), fishing, and pollution. On the other hand, excessive additions of nutrients to water bodies have led to excessive plant and algae growth affecting the ecosystem. This can in turn reduce or eliminate fish populations thereby increasing the outbreaks of microbes leading to increase in the cost of water purification, and degrading the cultural services water provides. This further keeps people from swimming, boating, and recreational activities (MEA, 2005).

2.2. Indirect Drivers to water as an ecosystem service

There are different indirect drivers of the ecosystem that influences the changes that are being experienced in the ecosystem today. The drivers includes cultural and religious, demographic, economic, socio-political, and scientific and technological.

2.2.1. Cultural and religious influence

Culture is accepted as complex whole that includes knowledge, belief, art, morals, law, custom, and any other capabilities and habits acquired by man as a member of society (Tylor, E.B. 1974). It is also the way of life of particular sets of people. Religion is the adherent acceptance of certain beliefs and rituals which involves a discerning faith in spiritual thoughts and a study of inherited ancestral traditions, knowledge and wisdom that as to do with the understanding of man (wikipedia, 2006).On the other hand, looking at culture and religion on the context of

ecosystem , it may be most useful to focus on the values, beliefs, and norms that a group of people share and that have the most influence on decision making about the environment. In this sense, culture conditions the individual's perceptions of the world in which he or she lives, influences what he or she considers important, and suggests courses of action that are appropriate and inappropriate. Although culture is most often thought of as a characteristic of national or ethnic groups, this definition also acknowledges the emergence of cultures within professions and organizations, along with the possibility that an individual may be able to draw on or reconcile more than one culture. As people migrate from one region to the other, they tend to adapt, share, interact and accept the norms and values of the society they find themselves. This changes in their ways and doings affects the ecosystems in the long run.

2.2.2. Demographic influences

This is the effect of population growth that leads to migration of people from region to region and from one locality to another locality. The high concentration of people in one locality due to presence of basic amenities, for example high migration from rural to urban areas or migration from developing nations to developed nations. The increase in demand in this area for basic sustainability of lives invariably affects the ecosystems in general. For example, more land space will be occupied leading to competition for survival by man and animals which indirectly leads to change of habitat of man or animal.
The world population has doubled within the past forty years, reaching about 6 billion in 2000, such that most of the growth a verse experienced in the developing nations (UN, 1999). On the other hand, at this period, the birth rates in most part of the world decline drastically, while the life expectancies became steady. During the early 21st century, there was sharp decline in the population growth in most regions of the earth. Nevertheless, despite the declining growth rate, the world's global population is most likely to increase to about 3 trillion by 2050 (Lutz et al, 2003).

2.2.3. Economic influences

Over the years, humans have tried to improve on their livelihood by acquiring and demanding for various ecosystem services. The increases in demand on these services have greatly affected the structure and the ecosystem. Take for example; the food chain has been altered due to survival and high demand for non agricultural products and competition for food. Economic growth, changing consumption patterns, and structural transformation have been the other of the day in most part of the world. The increase in per capita income of individual has led to a change in demand from food to social amenities for their basic comforts. The high demand for industrialized goods and services thus, affects the ecosystem due to the high demand of raw materials used during the production of these goods and services. In 2000, agriculture accounted for about 5% of the world gross domestic product (GDP), industry for 31%, and service industries for 64% (Rosen, 2002).

The indirect effect of the economic influences on the ecosystems depends on a number of factors, these include; the location of the activity, the available

resources and ecosystem condition ,economic and governmental policies, available technologies and the type of goods and services demand.

Table (3), shows the changes in the per capita gross domestic product growth rates in different region of the world over some period of years.

Table 3: Per capita gross product growth rate for related region and time periods (% per year)

Region	1870 - 1913	1913 – 1950	1950 – 1980	1980 – 1992	1990-2000
Western Europe	1.3	0.9	3.5	1.7	1.7
Australia,Canada, New Zealand, USA	1.8	1.6	2.2	1.3	1.9
Eastern Europe	1.0	1.2	2.9	-2.4	0.6
Latin America	1.5	1.5	2.5	-0.6	1.4
Asia	0.6	0.1	3.5	3.6	3.2
Africa	0.5	1.0	1.8	-0.8	0.1
World (Sample of 199 countries)	1.3	0.9	2.5	1.1	1.5

Source: Maddison A. 2003: The Word Economy: Historical Statistics. OECD: Paris, France.

2.2.4. Socio-political influences

This is a conceptual understanding of the influences of decision-making processes from and public participation. Socio-political drivers may be some of the most fundamental elements of how humans influence the environment. The political situation of a particular region will determine its environmental impact on the ecosystem. A region that is inflicted with war will definitely cause degradation to the ecosystem. This will inevitably lead to environmental declination creating poverty, underdevelopment, overexploitation of marginal resources, and in extreme cases, famine and social destruction (Berhe, 2000).

2.2.5. Scientific and technological influences

The advancement in scientific and technological know-how in the world today has both negative and positive advantages to the environment. As the innovation from technology made work easier and relatively fast, it has as well affected the environment negatively. For example, introduction of different chemical fertilizer in agricultural activities leads to high yield in harvest. Consequently, this fertilizer permeates into groundwater, polluting water table and affecting the consumption of water and increasing wastewater flow rate.

3. VALUATION OF WATER AS AN ECOSYSTEM SERVICE

The valuation of water in this context will not be restricted only to the anthropocentric view, but will be linked to a wider perspective. The ecological, socio-cultural, natural ecosystems and also the intrinsic are all essential for comprehensive evaluation of water ecosystems.

Ecosystem valuation can be difficult to analyse; due to the criticisms that arises as monetary factors is being allocated to natural resources. The price tag is often necessary as government and their agencies are faced with competitive budgeting to protect natural resources. It depends on people's perceptions on what they think has positive or negative influences on their well-being (Lambert, 2003). Over the years, the natural endowments have been taken for granted so much that we tend not to appreciate its importance to our livelihood. It is therefore, pertinent that monetary values are accepted as measure of "economic value". The amount people are willing to pay for a particular service reflects how much of other goods and services they are willing to give up to get it. In other words, the value of ecosystem services is provided by estimation of the willingness to pay, whether or not the payment is really made.

The importance of water as an ecosystem service, its magnitude and how it will change with changes in the ecosystem will determine its valuation. Also, who provides this service, in what way and for what particular purpose and what alternative services can be provided in place of water will give a conceptual evaluation (Pushpam, 2005).
The conceptual approaches to estimation of water uses can be analysed in different ways. The initial step is to be able to determine water usage as to defining the methods to be used to meet the objectives. A good account of a detailed level is required to estimate the time. The characteristics and nature of the types of the users, manpower availability and availability of water-use data from several sources needs to be evaluated. There are several different groups of water-use data, identification (names, addresses), hydrologic (rivers, aquifers, and watershed), geography (location of points of interest) and rate or volume.

4. WATER TREATMENT TECHNOLOGIES

The growing demand of water has made it paramount to treat used or wastewater. The demand for water supplies from the users such as homeowners, hospital, factories, restaurants, golf courses, recreations and agricultural operations has been the drawing mechanism behind the distribution of water (Haested Methods, 2003). Water treatment has been dated back to the 200BC. Treatment of water is done at this time by allowing the natural action of soil, sand and course gravel to filter water (Patrick et al, 2005). Boiling the water and allowing the water to settle in the reserviour or basin remove suspended solids or particles in water.

In urban areas, water is collected from a natural water body such as stream, river, or underground aquifer. The water is subsequently stored in the reservoir for further usage. The need to supply quality water to consumers, water has to

undergo several treatment processes. The processes remove any organic substances, chemical, or harmful substances to human health. (CRC, 2003).

In the western world type of solution provision to centralised water and wastewater, handling systems including water and sewer nets, costs a minimum of around $US150 to $US300 in capital costs per person (Varis et al, 1997). Some European nations such UK need to improve on the water quality standard to meet up with the European standard. The new European water quality standard will be met when UK invest about $US60 billion in wastewater treatment over a period of 10 years. This investment will automatically amounts to $US1000 per capital for about 0.6% of GDP spent on wastewater treatment (Serageldin I, 1994). In Central and South America and Africa, sewer connection cost will vary around $US120-$US235 with a median cost of $US150 (Franceys et al, 1992).

In recent times, water treatment technology has improved drastically to provide potable and quality water. Quality water must have the following characteristics.

- It must be odourless, colourless and with good taste
- It must be free of contagious materials that can cause sickness.

In today's contemporary water treatment technology, a treatment plant must be able to meet the following objectives: pre-treatment, prefiltration, filtration, chemical treatment, and disinfection.

4.1. Pre-Treatment

This involves the removal of floating particles (debris) such as weeds, papers, leaves and other materials by using screens. Volatile chemicals that can cause odour or taste to water can also be removed using aeration. In addition, sedimentation is carried out to remove dirt and some heavier materials. Filtration through sand beds removes the remaining particulates and finally, chlorination of the water to disinfect and oxidize it to remove some organic chemicals.

4.2. Prefiltration

This operation is the addition of chemicals such as acryl amide and epichlorolydrin to water to flocculate and filter out suspended particles.

4.3. Filtration

This is carried out by the use of sand beds, where water that passes through these sand beds is filtered as the suspended and colloidal materials are removed.

4.4. Chlorination

This is the final step in water treatment. Chlorination of water reduces the hardness of the water has it removes excessive amounts of calcium and magnesium in water. It also, eliminates bacteria pollution, the regrowth of bacterial and kills pathogens that cause diseases such as typhoid and cholera.

5. SOCIAL AND TECHNICAL SYSTEMS

The global increase in population as increased the demand for various ecosystem services. These ecosystem services have links with the social and technical systems, which are motivated by human needs and demands, nevertheless some example of scenarios that can motivate the links are depicted in figure 2 and figure 3, respectively. The uneven supply of water for utility affects activities such as agriculture.

Human needs and demands have greater influence on changes in technology to meet up the growing demand of human. The drastic changes on the other hands, transcends to the manipulation of the ecosystem, such as provision of quality water, which as to undergo different stages. Supply of quality water in areas such as urban community requires pipes networking, therefore during the process of construction and laying of pipes, there are landscaping, digging and all sort of land deformations that affect the original nature of the earth surface in that particular area. Therefore, the effect on ecosystem during the quest to meet the demands and needs of man affect greatly the ecosystem. The fact is that man's wants is unlimited, so it is imperative that the need to meet up with the sustainability of the environment should be our utmost priority.

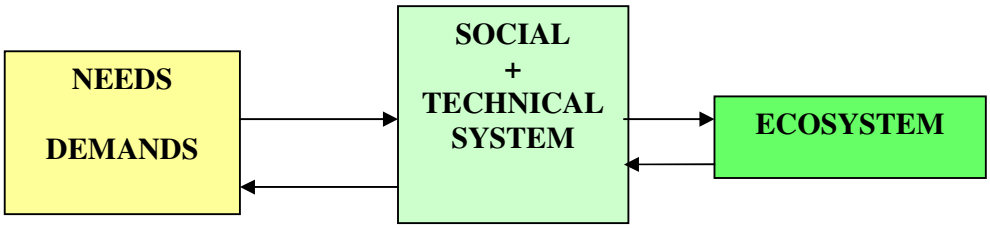


Figure 2: Conceptual model

The need for alternative choices of sources of water such as from tap or bottled water, have some great implication or effects on the social and technical supports that comes from the provision of this water. The high demand on water in this instance increases the stress on the energy required to provide the water. Consequently, have influence on the investment, quality of production, pipes, production of bottle either plastic or glass and sustainability of the ecosystem service (water).

The desire to meet such demand causes some distortion in the ecosystem and this need to be checked.

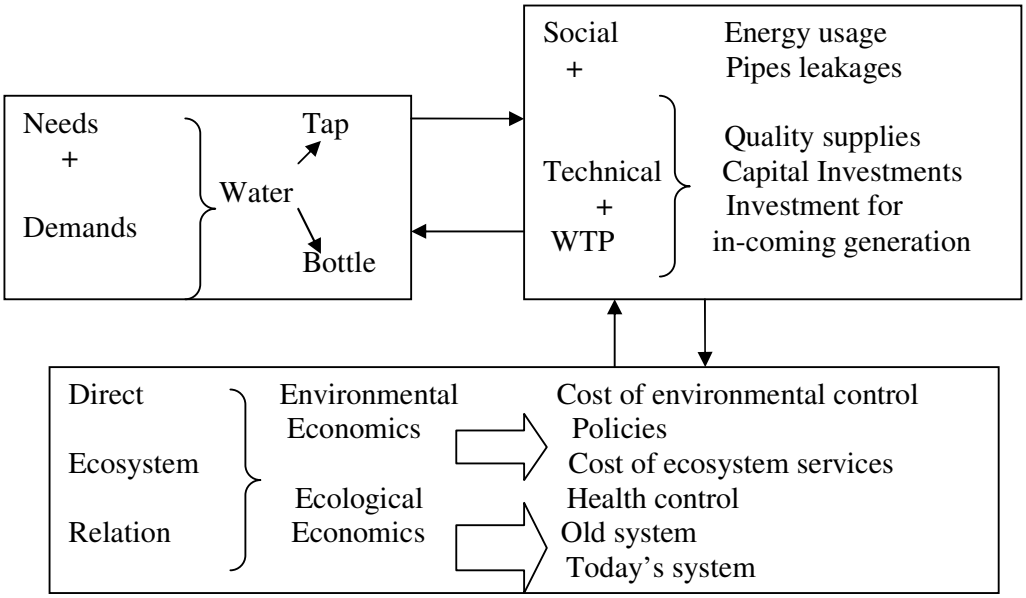


Figure 3: Scenario of human demands on water with subsequent influences on ecosystem

5.1. Willingness to pay

Ecosystem cannot be sustainable managed without a proper understanding of how the services they provides is been impacted by the activities of man. The willingness to pay studies is carried out so that an efficient use of water on the point of view of the customers' is understood. Such the knowledge of the customers' and attitude towards the provision of these ecosystems is evaluated. The criticism to this method is that customers' tend to give a false answer during evaluation of willingness to pay (Rogerson, 1996). Thus the most probably reliable source of information concerning willingness to pay is the derivation of pursued survey of organized and informal water vending that will be carried out both in rural areas and cities (Rogerson, 1996). The willingness to pay for water as an ecosystem is related to water usage.

5.2. Contingent valuation

This method is used to analyse individuals' perception to how much they are willing to pay. It is a direct survey approach for estimation of customer preferences (Mitchel and Carson, 1998). It has been frequently used to evaluate the values people concur to due to changes in the quality or quantity of environmental goods (Morrison, et al., 1996). The goal of contingent valuation is to measure the compensating or equivalent variation for the good in question. Compensating variation is the appropriate measure when the person must purchase the good, such as an improvement in environmental quality. Nevertheless, respondent in a poll or survey might tend to give a wrong perception to the initial willingness to, when other related or unrelated resources are available. Therefore, the contingent valuation is most time criticised in literatures. Because it could be subjected to some problems and it does not readily differentiate the components of services individuals value the most. In some surveys respondents expressed their willingness to pay or willingness to accept

compensation for goods and services from the viewpoint of concerned citizen rather than as a customer or user of the good or service (Sagoff, M., 1988). Other critics, such as Cameron, J. I. (1997 reported from the survey in Hawkesbury-Nepean watershed in Sydney, Australia, that it was difficult for respondents to state their willingness to pay for improved water quality. Some of these respondents stated that the payment they will be paying towards the supply of improved water quality would be solely done from their personal will as a symbol of donating to a noble cause.

5.3. Choice modelling

This method is a preferred method when evaluating individual attributes to different services. It gives a better idea of the individual preferences from groups of services or attributes. The modelling is characterised with organization of sets of choices and individual selection or ranking is expected. It is one of the good approaches to analyse the relative values of different attributes of a non-market goods such as water services.

This modelling is formulated by arranging set of choices, which are later modelled to estimate preferences for alternative standard and practices. Choice modelling gives a better social analysis than economic analysis of non- market good attributes.

Choice modelling (CM) can be implemented as it undergoes some stages:

- Selection of attributes

This is the identification of relevant attributes of the goods or services that are to be valued. In this case, literature reviews and focus groups are used during selection of attributes that are to people, while consultation of experts helps to identify the attributes that will be impacted by the policies.

- Assignment of levels

The attributes to be considered should be realistic, understandable, and feasible. It should also cover a wider range of respondents' experimental maps. For a proper selection of attributes levels, pilot surveys, focus group and literature review are consulted. In addition, a baseline 'status quo' level is included.

- Choice of experimental design

The levels of attributes are combined into different alternative scenarios by using statistical design theory to present it to respondents. The effects of each individual attribute presented and the extent to which the behaviour is connected with the variations in the combined attributes is estimated using the factorial design choices. This design gives a larger number of combinations to be evaluated with a precise and easier evaluation.

❖ Construction of choice sets

The scenarios or profiles that were identified by the experimental design are grouped into choice sets that will be later presented to the respondents. It can be administered individually or in-group.

❖ Measurement of preferences

For individual measurement of preferences, rating, ranking or choices can be carried out.

❖ Estimation procedure

Statistical regression or maximum likelihood estimation procedures such as probit, logit, ordered logit etc. are used. Choice-specific attributes have to interact with variables that do not vary across alternatives.

6. GÖTEBORG WATER MANAGEMENT

Sweden has been the major pioneer of environmental legislators among European Union communities.
Regional associations unlike other localities manage the water supplies in Göteborg, which are the sole responsibilities of 289 local authorities or municipalities; with exception of Stockholm and Malmo. Municipality owns water and wastewater assets in Göteborg, though their operations are managed, directly by the municipality owned company. They are also, governed through non-public and non-profit organization. (SEPA, 1998)

The water companies in Göteborg, through the municipality levy charges for their services. Although, laws governs this charges as they are expected to be non-profit making.

Most of the utilities are covered by the charges. Farmers and landowners in the rural areas are not charged for water usage for agricultural operations as all landowners have the right to groundwater resources below their property and nearly 800.000 wells are privately owned (Boverket, 1995). Industrial users pay for water supply and wastewater treatment at cost. While, larger users of water are given some discounts (EU Country Report, 2002).

In Sweden, there are more than 2 000 municipal water supply works and 67 000 km of municipal water pipes in the country (SEPA, 1998). These pipe networking provide 7.7 million consumers or 90 percent of the population with high quality water. The water consumption was at its highest level at the end of 1960, when 800 million cubic meters were used annually.

The high rate of water consumption over the years will lead to about 20% increase in the leakages in the pipe system. Presently, consumption rate is about 730 million cubic meters, that 200 litre per person in a day at household level (IWSA, 1998). In Sweden, the use of chemicals to treat water has been reduced drastically. From the yearly drinking water production 25% is surface water treated by artificial infiltration, 24 % from groundwater and the remaining 51% is withdrawn from surface water sources (Ødergaard et al., 1996).

Water supplies to customers are determined by the income status of the customer, whether they are low-income earners or high-income earners. The location of household and geographical citing can also influence the water supply charges. (UNESCO, 1998). Water distribution systems includes public wells or springs mostly used in rural area, street water vendors, temporary water in tanks, and effective pipe system distribution networks from the pump stations.

Swedish municipal authority works efficiently such they compete favourably well with other European countries. Swedish water management authority charges less than half the price most other European countries charge for drinking water (IWSA, 1998).

Table 4, shows the average water rate of 200 cubic metre of drinking water in major European Union cities.

Table 4. Average price list for 200m^3 drinking water in major EU cities.

City	**Euro (€)**
Amsterdam	153
Brussels	306
Geneva	322
Hague	241
Helsinki	174
Liege	229
London	140
Lyon	268
Marseille	256
Newcastle	275
Odense	143
Paris banlieu	265
Turku	254
Gothenburg	80
Swedish average	105

Source: (IWSA" International Service Water Association").

Göteborg has experienced high water leakages over the years due to the geological and topographical condition of the area. The high pressure, demand and population density has affected the leaking rates and bursting of pipes (Peter Stahre et al, 1995).The various indicators that are related to water leakages in Göteborg from 1996 to 2000 are shown below.

Table (5) Performance indicators for Göteborg related to water leakages

	1996	**1997**	**1998**	**1999**	**2000**
Water leakages in m3 per kilometre of water main per day					
Göteborg	20.7	19.5	14.6	15.1	17.7
Number of bursts on water mains per 10 kilometre					
Göteborg	2.4	2.2	1.5	1.9	1.5
Number of burst / 1000 service connections					
Göteborg	2.5	1.7	1.1	1.5	1.7
Pipe renewal rate in % of the total length of water mains					
Göteborg	4.1	8.1	4.0	3.4	3.6
Net cost for operation and maintenance in Euro (€) per metre of water main					
Göteborg	2.5	1.7	1.1	1.5	1.7

Source: Peter Stahre and Jan Adamsson, 1995: Performance benchmarking: ' A powerful management tools for water and wastewater utilities.

7. METHODOLOGY

In this study, analysis will be carried out considering preferences to consumption of water. The estimation of water using a non- market valuation will be analyzed. To determine the preferences to water consumption as regards sustainability, evaluation will be made to check the links to some basic social and technical services and, its consequential effects on other ecosystem services.

The willingness to pay for consuming water from two different sources will be evaluated using questionnaire from sample survey of different responses. This questionnaire is built up considering the literature reviews on water ecosystem services. The contingent valuation and choices modeling is chosen for the methodology in this study such that a critical analysis of the behavioral influences on the consumption of water from two different perceptions will be reasonably analyzed, that is from tap water or bottled water.

The questionnaires that will be used in this study has be constructed in such a way that it will give true pictures and scenarios of different behavioral attributes to demand of water as an ecosystem service. Some scenarios are designed so that alternative choices can be made as regards water consumption. For example, the desire to drink water from a tap water or bottled water will eventually have some influences on the social and technical supplies or usage of water. That is the technological attribute of production and supplies of water, will obviously have some effects on other ecosystem services such as land, climate etc.

This survey will precisely evaluate the responses from individual selected population in Göteborg, as to their preferred source of drinking water either tap water or bottled water. The reason for choosing one of the sources will be considered looking at the availability, safety, cost and quality. Also, environmental impact of preferring either source will be evaluated, which will bring the issue of willingness to pay to maintain a sustainable environment for disposing of used bottled (plastic) or willingness to pay for maintenance of pipes or fixing of leaking pipes in the process of tap water supply.

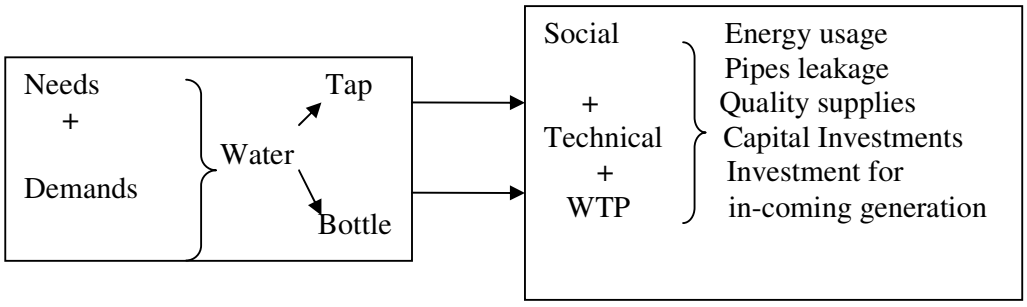
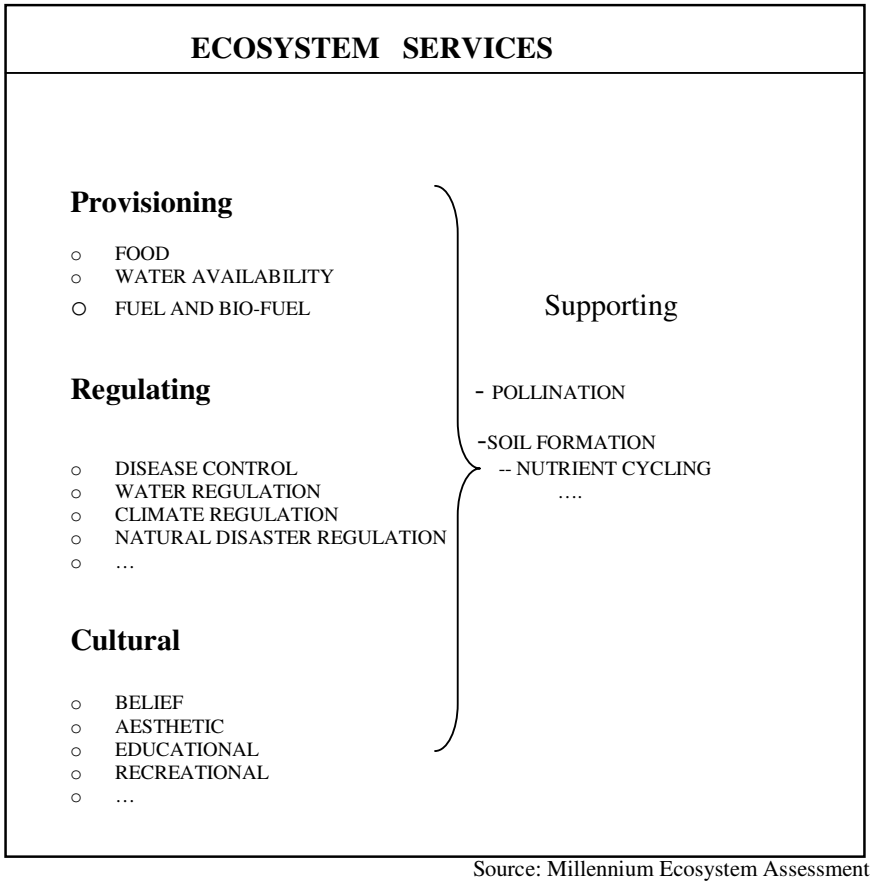


Figure 4. Conceptual model on behavioural influences on water consumption.

In addition, the direct and indirect effect on the water ecosystem will be tested. Subsequently, how well do individual appreciate the use of water for other recreational resort such as swimming, learning purposes, sailing and fishing will be most considered. Eventually, the willingness to accept policies that protect the water ecosystem will be evaluated and consequently, willingness to pay to protect and how much will be willing to be paid to protect the service.



Source: Millennium Ecosystem Assessment

Figure 5: Ecosystem services (Life on earth- diversity)

The need to implement the Millennium development goal is paramount to the sustainable development of human well-being. In the existence of man, it is imperative that the access to basic necessities of life according to the Millennium Ecosystem Assessment (MEA) will go a long way to improve global poverty, increase human life span and reverse the degradation of many ecosystem services. This study will thus; revolve round the MEA so that a meaningful conclusion will be arrived at to balance the availability of water ecosystem services with social and technical systems. Figure 6 shows the constituents of human well-being.
This includes health care systems, economic security, equity and fairness, and environmental security to mention a few. The implementation of all these will initiate freedom of choice and action.

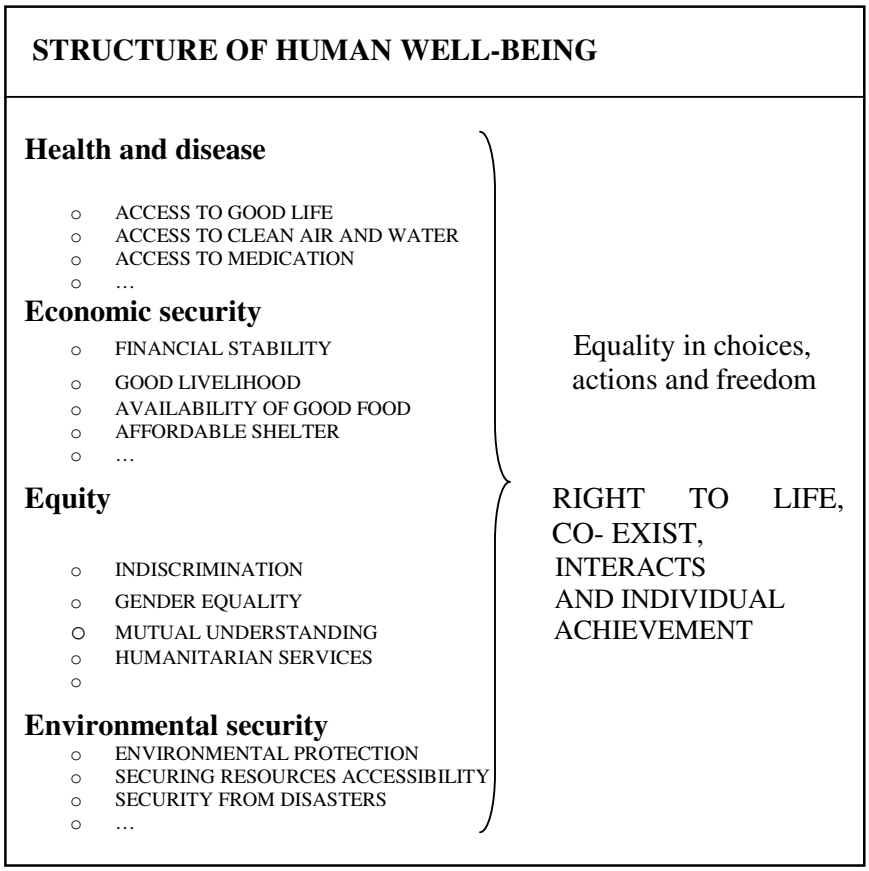


Figure 6: Structure of human well being Source: Millennium Ecosystem Assessment

7.1. Models

The implementation of WTP in the contingent valuation (CV) survey will be done in a dichotomous choice (DC) model that has been often used since popularized by Hanemann (1984). In this analysis a random sample of the population in Göteborg is asked a "Yes" and "No" question to indicate their willingness to consume water from tap water or bottled water and subsequently their willingness to pay for sustainability of affected social and technical improvement of this ecosystem services. The question format is usually called single – bounded dichotomous choice (SBDC) question because this asks question from respondent only on one close ended question.

A typical double- bounded dichotomous choice (DBDC) used in this questionnaire often ask questions from individual respondent on the basis of two bids and asks for "Yes" or "No" vote as to whether the respondent's WTP equals or exceeds each bid. The subsequent step of bids is conditional on the respondent's response to the first bid; it is therefore, lower if the first response is "No" and higher if it is "Yes". It is imperative that the use of double- bounded (DB) format can be implemented, though; there could be some unexpected increase in statistical efficiency that can resolve into bias in moving from single- bounded (SB) to a DB format. In other words, responses to second bid are sometimes evident to be

inconsistent from the initial bid. Therefore, the distribution of underlying preferences from answers of the initial questions may not be the same as implied to by the responses to the initial and subsequent questions. To buttress these facts, a number of studies have been carried out to deal with this issue. For example, McFadden (1994) concluded, that the DB elicitation method is internally inconsistent in that the hypothesis of the first and second responses in the DBDC experiment are drawn. Cameron and Quiggin (1994) find out that the values implied by the first and second responses are highly correlated and may be drawn from the same distribution, are nevertheless, not identical.

It is imperative that the need for a balance ecosystem is the main aim of this study. Therefore, the response from questions in the questionnaires will be statistically evaluated to give conclusive remarks on the evaluation of water as an ecosystem service.

In addition, behavioural influence, social and technical effects and the influences on other ecosystem services will be evaluated at the end of the survey.

8. RESULTS AND DISCUSSIONS

The responses from the pilot questionnaires will be discussed in relation to the absolute response of the individual responses and will be consequently compared to give a concise conclusion on the pilot survey on evaluation of water ecosystem service.

Two distinct stakeholders in the field of water sustainability were approached independently for their view on water as an ecosystem service with respect to their individual choice on sources of drinking water; that is from tap water or bottled water.

8.1. Analysis of responses from Behavioural Survey

In the behavioural analysis survey, both parties agreed that they prefer tap water as their source of drinking water. As long as the water is accessible and safe, one of the respondents suggested, while the other was undecided on why he prefer the tap water. On the other hand, one of the respondents says bottled water could be of good quality and the other concluded that it is easy to carry around. In conclusion, both parties suggested that it is most important to consider the environmental effect of disposing and recycling bottles (plastics) and the two respondents are willing to pay for the environmental sustainability of the environment as long as they have the financial resources. In addition, both parties indicated that as long as tap water is of good quality compared to bottled water, they prefer the tap water and are willing to pay more for the maintenance of the pipes and other logistics of water delivery.

8.2. Analysis of responses from Social and Technical Survey

Considering the analysis of responses for the social and technical analysis survey on water usage, all respondents agreed that it is imperative to fix all leaking pipes, to reduce the great loss in capital on water supplies. Reduction of leaking water from companies and domestic use alike by 10% beyond Economic Levels of Leakages (ELL) will cost at least around £2.5 billion at customer's cost (Philip, 2006).
The respondents supported the need to reconstruct damaged pipes and fixing of leaking pipes for continuous quality supplies of water, even if it has to take extra cost. Finally, consumers are willing to pay and invest for a better drinking water system supplies for incoming generations.

8.3. Analysis of responses from Direct Ecosystem Relation Survey

From the responses of the pilot questionnaire, it is obvious that the level of water ecosystem sustainability in Göteborg has changed drastically. Both parties also agreed that it is of great priority to regulate sewer overflow and other pollution effects on water ecosystems. The respondents are willing to pay for water as a free ecosystem and it regulations. They are also willing to accept the inconveniences

that might arise due to changes in policies to protect water ecosystem services because they appreciate the use of water as other recreational services. In addition, they are willing to pay extra cost to improving the degradation caused by the high demand on water as an ecosystem services.

One of the respondents suggested that it will be most appreciated if real improvement can be seen has she is willing to pay to see a positive effect on the water ecosystem services and not causing more environmental burden on the system on the pretence of improving water ecosystem services.

9. CONCLUSION AND RECOMMENDATION

Considering the results from the few numbers of respondents, it still indicates some level of appreciation of water as an ecosystem service. The need to improve on the quality and efficiency of supply of water for domestic, commercial and other recreational activities is highly supported.

In addition, it can be concluded that consumers are willing to pay, not just paying for the services received but also willing to pay extra for maintenance of leaking pipes and reconstruction of degraded water ecosystems services as long as is within their financial capability. The consumption of available and safe water from the tap will over-ride the extra cost of maintaining a clean environment from the disposal of used bottled water.

This study still needs to be continued on a rather larger scale, such that more numbers of responses from respondents are analyzed. Statistical regression of choice modeling should be explored to have better convincing conclusion on the choice of sustaining water ecosystem services.

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APPENDIX

Appendix A: Sample of Pilot Questionnaire on Water as an Ecosystem Service

SECTION A: BEHAVIOURAL ANALYSIS SURVEY

Your response to the following questions will be treated as confidential as possible and will remain anonymous.

Pleas tick one box that best suit your opinion.

1: Which **Source** of drinking water do you prefer?

- **Tap** --- if you prefer tap, go to question 2
- **Bottle** --- if you prefer bottle, go to questions 3 and 4

2: Why do you prefer **tap water**?

- It is always accessible and available
- It is cheaper than bottled water
- It is safer
- Undecided

3: Why do you prefer **bottled water**?

- I prefer the taste
- It is convenient to carry
- It is of good quality
- Undecided

4: Do you consider the **recycling symbol**s when you buy bottled water?

- **Yes**, I check before I buy it
- **No**, I do not, I just buy and drink my water
- **Undecided**

5: If **YES** was your answer to question 4 please go to **Question 6**; if **NO** was your answer please go to **Question 7**?

6: Do you **often dispose** your used bottle into appropriate **disposal bin**?

- **Yes**, if I can find it around me
- **Yes**, I dispose it later in appropriate place
- **No,** I just throw them away
- **Undecided/** Not sure

7: Assuming you choose **non-recyclable** bottled water. Do you have an **idea** of the **environmental effect**?

- **Yes**, I have some idea of the effects on the environment
- **No**, I do not have an idea of the effects
- **Undecided** or I do not care

8: If you are told of the effects of non-recyclable materials, will you be **willing to pay** for the environmental sustainability?

- **Yes**, if I have the resources
- **No**, even if I have the resources
- Undecided or I do not care

Consider a theoretical case where tap water is cheaper than bottled water and both are of the same quality. And tap water is readily accessible everywhere.
Use this scenario to answer the following questions.

9: Which **one** will you **prefer** considering the above scenario?

- **Tap water**
- **Bottled water**

10: If you choose **tap water** go to **Question 11**, if you choose **bottled water** go to **Question 12**.

11: Are you **willing to pay** more for the maintenance of the pipes that deliver the water?

- **Yes**, if I have the resources
- **No**, even if I have the resources
- **Undecided** or I do not care

12: Why do you **prefer** bottled water?

- Because I am **used to it**
- Because I can **only trust it**
- Because I **have the resources to buy it**
- I **would insist** but I **do not** have the resources
- **Undecided**

SECTION B: SOCIAL AND TECHNICAL ANALYSIS SURVEY

At present some 17% of water produced in Göteborg leaks during transport in the drinking water system. This can be corrected, but might lead to significant increase in water rates.

Please tick box closest to your opinion.

Attributes	Level A	Status quo
Water availability	**Fix leakages and pay more water rates** ☐	**Do not fix leakages, same water availability and pay less water rates** ☐
Water quality	**Renew pipe system to raise water quality and pay more** ☐	**Do not renew system and pay less** ☐
Pipes reconstruction	**Fix leaking pipes for quality supplies despite the extra cost on my water rates**  ☐	**Do not fix pipes because this will increase my water rates**  ☐
Water bills	**Willing to pay for investment for future generations**  ☐	**Unwilling to pay for investment** ☐

SECTION C: DIRECT ECOSYSTEM RELATION

In this section, water as an ecosystem service will be assessed from the Millennium Ecosystem Assessment point of view. In the Millennium Ecosystem Assessment, water is assessed with the effect of ecosystem changes for human well- being and the scientific basis for the actions needed to improve the conservation and sustainable use of those systems and their contribution to human well–being.

In Göteborg, the cost of water treatment, water protection areas and delivery to the consumer is approximately 10 Kr/ m^3.

Note that, the challenges of reversing the degradation of water ecosystem as services while meeting increasing demands for services may require scenarios that involve significant changes in policies.

Below are some scenarios where we need your response, and we will appreciate a high degree of unbiased in your response.

Please tick one box that most closely relates your opinion.

1. How do you view the **level** of **water ecosystem sustainability** in your locality?
   - ❑ It is well protected and managed
   - ❑ It is pristine i.e. unchanged by human development
   - ❑ Changed drastically
   - ❑ I do not know

2. Do you think we should further **regulate** sewer overflows and other pollution effects on water ecosystems?
   - ❑ **Yes**, it absolutely necessary
   - ❑ **No**, we have done enough
   - ❑ **Undecided**

3. If **YES** was your response to **Question 2** go to **Question 4**, if **NO** was your response go to **Question 5**

4. Are you **willing to pay** for water as a free ecosystem and its regulation?

   - ❑ **Yes,** I am willing to pay
   - ❑ **No,** I am not willing to pay, even if I have the resources to pay
   - ❑ **Undecided** or I do not care

5. Why do you prefer not to regulate sewer overflows and other pollution?

   - ❑ Because it is **too expensive**
   - ❑ Because it is an **extra burden**
   - ❑ Because I **do not want to pay** for the service
   - ❑ **Undecided** or I do not care about the water ecosystem

6. How much do you appreciate water as a recreational service?

   - ❑ Very much
   - ❑ Only slightly
   - ❑ Undecided

7. How often do you (or family) use water as recreation, such as swimming, learning purposes, fishing and sailing?

   - ❑ Very often during our leisure time
   - ❑ I do not use it at all
   - ❑ Undecided

8. Are you willing to accept policies that protect the water ecosystem services even if it will cost you extra expenses?

   - ❑ **Yes,** I am willing to accept and pay
   - ❑ **Yes,** I am willing to accept but I do not want extra payment
   - ❑ **No,** I am not willing to accept
   - ❑ **Undecided** or I do not care

9. How much would you be willing to pay (assuming you already pay **10Kr/ m^3**) for investing in water as an ecosystem service?

   - ❑ 15 kr/m^3
   - ❑ 20Kr/ m^3
   - ❑ 25 Kr/ m^3
   - ❑ 50 Kr/ m^3

10. Are you willing to accept the changes and inconveniences it might cause you due to improving and protection of water ecosystems?

    - ❑ **Yes**, I accept
    - ❑ **No**, I do not accept
    - ❑ **Undecided**

11. Please kindly state why you are willing to pay such an amount for the option(s) you choose above.

_____
_____
_____
_____

Section D:

For a better understanding of your opinions, please kindly answer the following:

1. Age: _____

2. Gender: □ **male** □ **female**

3. Marital Status: □ single □ married □ divorced □ widowed

4. Highest Level of Education: □elementary school
□ secondary school
□ trade/ technical college
□ university degree
□ post-graduate degree

5. Occupation: □ retired
□ unemployed
□ employed – please specify _____

6. Total Annual Household Income: □
□
□
□
□
□
□

Do not write your name on the questionnaire. Thank you for your time.

Appendix B: Response to questionnaire from stakeholder 1.

SECTION A: BEHAVIOURAL ANALYSIS SURVEY

Your response to the following questions will be treated as confidential as possible and will remain anonymous.

Pleas tick one box that best suit your opinion.

1: Which **Source** of drinking water do you prefer?

xTap --- if you prefer tap, go to question 2
- **Bottle** --- if you prefer bottle, go to questions 3 and 4

2: Why do you prefer **tap water**?

- It is always accessible and available
- It is cheaper than bottled water

- ❑ It is safer

xUndecided

3: Why do you prefer **bottled water**?

- ❑ I prefer the taste
- ❑ It is convenient to carry

xIt is of good quality

- ❑ Undecided

4: Do you consider the **recycling symbol**s when you buy bottled water?

xYes, I check before I buy it

- ❑ **No**, I do not, I just buy and drink my water
- ❑ **Undecided**

5: If **YES** was your answer to question 4 please go to **Question 6**; if **NO** was your answer please go to **Question 7**?

6: Do you **often dispose** your used bottle into appropriate **disposal bin**?

- ❑ **Yes**, if I can find it around me

xYes, I dispose it later in appropriate place

- ❑ **No,** I just throw them away
- ❑ **Undecided/** Not sure

7: Assuming you choose **non-recyclable** bottled water. Do you have an **idea** of the **environmental effect**?

xYes, I have some idea of the effects on the environment

- ❑ **No**, I do not have an idea of the effects
- ❑ **Undecided** or I do not care.

8: If you are told of the effects of non-recyclable materials, will you be **willing to pay** for the environmental sustainability?

xYes, if I have the resources

- ❑ **No**, even if I have the resources
- ❑ Undecided or I do not care

Consider a theoretical case where tap water is cheaper than bottled water and both are of the same quality. And tap water is readily accessible everywhere.
Use this scenario to answer the following questions.

9: Which **one** will you **prefer** considering the above scenario?

xTap water

- ❑ **Bottled water**

10: If you choose **tap water** go to **Question 11**, if you choose **bottled water** go to **Question 12**.

11: Are you **willing to pay** more for the maintenance of the pipes that deliver the water?
xYes, if I have the resources
- **No**, even if I have the resources
- **Undecided** or I do not care.

12: Why do you **prefer** bottled water?
- Because I am **used to it**
- Because I can **only trust it**
- Because I **have the resources to buy it**
- I **would insist** but I **do not** have the resources
- **Undecided**

SECTION B: SOCIAL AND TECHNICAL ANALYSIS SURVEY
At present some 17% of water produced in Göteborg leaks during transport in the drinking water system. This can be corrected, but might lead to significant increase in water rates.

Please tick box closest to your opinion.

Attributes	**Level A**	**Status quo**
Water availability	**Fix leakages and pay more water rates** x	**Do not fix leakages, same water availability and pay less water rates** ☐
Water quality	**Renew pipe system to raise water quality and pay more** x	**Do not renew system and pay less** ☐
Pipes reconstruction	**Fix leaking pipes for quality supplies despite the extra cost on my water rates**  x	**Do not fix pipes because this will increase my water rates**  ☐
Water bills	**Willing to pay for investment for future generations**  x	**Unwilling to pay for investment** ☐

SECTION C: DIRECT ECOSYSTEM RELATION

In this section, water as an ecosystem service will be assessed from the Millennium Ecosystem Assessment point of view. In the Millennium Ecosystem Assessment, water is assessed with the effect of ecosystem changes for human well- being and the scientific basis for the actions needed to improve the conservation and sustainable use of those systems and their contribution to human well–being.

In Göteborg, the cost of water treatment, water protection areas and delivery to the consumer is approximately 10 Kr/ m^3.

Note that, the challenges of reversing the degradation of water ecosystem as services while meeting increasing demands for services may require scenarios that involve significant changes in policies.

Below are some scenarios where we need your response, and we will appreciate a high degree of unbiased in your response.

Please tick one box that most closely relates your opinion.

1. How do you view the **level** of **water ecosystem sustainability** in your locality?
   - ❑ It is well protected and managed
   - ❑ It is pristine i.e. unchanged by human development

   xChanged drastically
   - ❑ I do not know

2. Do you think we should further **regulate** sewer overflows and other pollution effects on water ecosystems?

   xYes, it absolutely necessary

   a. **No**, we have done enough

   b. Undecided

3. If **YES** was your response to **Question 2** go to **Question 4**, if **NO** was your response go to **Question 5**

4. Are you **willing to pay** for water as a free ecosystem and its regulation?

   xYes, I am willing to pay
   - ❑ **No,** I am not willing to pay, even if I have the resources to pay
   - ❑ **Undecided** or I do not care

5. Why do you prefer not to regulate sewer overflows and other pollution?

   - ❑ Because it is **too expensive**
   - ❑ Because it is an **extra burden**
   - ❑ Because I **do not want to pay** for the service
   - ❑ **Undecided** or I do not care about the water ecosystem

6. How much do you appreciate water as a recreational service?

xVery much
- Only slightly
- Undecided.

7. How often do you (or family) use water as recreation, such as swimming, learning purposes, fishing and sailing?

xVery often during our leisure time
- I do not use it at all
- Undecided

8. Are you willing to accept policies that protect the water ecosystem services even if it will cost you extra expenses?

xYes, I am willing to accept and pay
- **Yes,** I am willing to accept but I do not want extra payment
- **No,** I am not willing to accept
- **Undecided** or I do not care

9. How much would you be willing to pay (assuming you already pay **10Kr/ m^3**) for investing in water as an ecosystem service?

- 15 kr/m^3
- 20Kr/ m^3

x25 Kr/ m^3
- 50 Kr/ m^3

10. Are you willing to accept the changes and inconveniences it might cause you due to improving and protection of water ecosystems?

xYes, I accept
- **No**, I do not accept
- **Undecided**

11. Please kindly state why you are willing to pay such an amount for the option(s) you choose above.

I think it's worth it – for coming generations…!!!

_____
_____
_____

Section D:

For a better understanding of your opinions, please kindly answer the following:

1. Age: __46_____

2. Gender: □ **male** **x female**

3. Marital Status: □ single **x** married □ divorced □ widowed

4. Highest Level of Education: □elementary school
□ secondary school
□ trade/ technical college
□ university degree
x post-graduate degree

5. Occupation: □ retired
□ unemployed
x employed – please specify _____

6. Total Annual Household Income: □ 500 000 SEK/year
□
□
□
□
□
□

Do not write your name on the questionnaire. Thank you for your time.

Appendix C: Response to questionnaire from stakeholder 2.

SECTION A: BEHAVIOURAL ANALYSIS SURVEY

Your response to the following questions will be treated as confidential as possible and will remain anonymous.

Pleas tick one box that best suit your opinion.

1: Which **Source** of drinking water do you prefer?

- **X Tap** --- if you prefer tap, go to question 2
- ❑ **Bottle** --- if you prefer bottle, go to questions 3 and 4

2: Why do you prefer **tap water**?

X It is always accessible and available (available and safe except during travels)

- ❑ It is cheaper than bottled water
- ❑ It is safer
- ❑ Undecided.

3: Why do you prefer **bottled water**?

- ❑ I prefer the taste
- X It is convenient to carry
- ❑ It is of good quality
- ❑ Undecided.

4: Do you consider the **recycling symbol**s when you buy bottled water?

- ❑ **Yes**, I check before I buy it
- **X** **No**, I do not, I just buy and drink my water
- ❑ Undecided.

5: If **YES** was your answer to question 4 please go to **Question 6**; if **NO** was your answer please go to **Question 7**?

6: Do you **often dispose** your used bottle into appropriate **disposal bin**?

- ❑ **Yes**, if I can find it around me
- ❑ **Yes**, I dispose it later in appropriate place
- ❑ **No,** I just throw them away
- ❑ **Undecided/** Not sure.

7: Assuming you choose **non-recyclable** bottled water. Do you have an **idea** of the **environmental effect**?

XYes, I have some idea of the effects on the environment

- ❑ **No**, I do not have an idea of the effects
- ❑ **Undecided** or I do not care.

8: If you are told of the effects of non-recyclable materials, will you be **willing to pay** for the environmental sustainability?

XYes, if I have the resources

- ❑ **No**, even if I have the resources
- ❑ Undecided or I do not care.

Consider a theoretical case where tap water is cheaper than bottled water and both are of the same quality. And tap water is readily accessible everywhere.

Use this scenario to answer the following questions.

9: Which **one** will you **prefer** considering the above scenario?

- **X** **Tap water**
- ❑ **Bottled water**

10: If you choose **tap water** go to **Question 11**, if you choose **bottled water** go to **Question 12**.

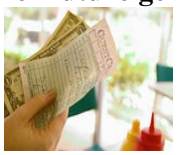
11: Are you **willing to pay** more for the maintenance of the pipes that deliver the water?

XYes, if I have the resources
- **No**, even if I have the resources
- **Undecided** or I do not care

12: Why do you **prefer** bottled water?
- Because I am **used to it**
- Because I can **only trust it**
- Because I **have the resources to buy it**
- I **would insist** but I **do not** have the resources
- **Undecided**

SECTION B: SOCIAL AND TECHNICAL ANALYSIS SURVEY

At present some 17% of water produced in Göteborg leaks during transport in the drinking water system. This can be corrected, but might lead to significant increase in water rates.
Please tick box closest to your opinion.

Attributes	Level A	Status quo
Water availability	**Fix leakages and pay more water rates** x	**Do not fix leakages, same water availability and pay less water rates** ☐
Water quality	**Renew pipe system to raise water quality and pay more** x	**Do not renew system and pay less** ☐
Pipes reconstruction	**Fix leaking pipes for quality supplies despite the extra cost on my water rates**  x	**Do not fix pipes because this will increase my water rates**  ☐
Water bills	**Willing to pay for investment for future generations**  x	**Unwilling to pay for investment** ☐

SECTION C: DIRECT ECOSYSTEM RELATION

In this section, water as an ecosystem service will be assessed from the Millennium Ecosystem Assessment point of view. In the Millennium Ecosystem Assessment, water is assessed with the effect of ecosystem changes for human well- being and the scientific basis for the actions needed to improve the conservation and sustainable use of those systems and their contribution to human well–being.

In Göteborg, the cost of water treatment, water protection areas and delivery to the consumer is approximately 10 Kr/ m^3.

Note tat, the challenges of reversing the degradation of water ecosystem as services while meeting increasing demands for services may require scenarios that involve significant changes in policies.

Below are some scenarios where we need your response, and we will appreciate a high degree of unbiased in your response.

Please tick one box that most closely relates your opinion.

1. How do you view the **level** of **water ecosystem sustainability** in your locality?
   a. It is well protected and managed
   b. It is pristine i.e. unchanged by human development
   X Changed drastically
   c. I do not know

2. Do you think we should further **regulate** sewer overflows and other pollution effects on water ecosystems?

   X Yes, it absolutely necessary
   ❑ **No**, we have done enough
   ❑ **Undecided**

3. If **YES** was your response to **Question 2** go to **Question 4**, if **NO** was response go to **Question 5**

4. Are you **willing to pay** for water as a free ecosystem and its regulation?

   X Yes, I am willing to pay
   ❑ **No,** I am not willing to pay, even if I have the resources to pay
   ❑ **Undecided** or I do not care

5. Why do you prefer not to regulate sewer overflows and other pollution?

   ❑ Because it is **too expensive**
   ❑ Because it is an **extra burden**
   ❑ Because I **do not want to pay** for the service

- ❑ **Undecided** or I do not care about the water ecosystem

6. How much do you appreciate water as a recreational service?

   X Very much
   - ❑ Only slightly
   - ❑ Undecided

7. How often do you (or family) use water as recreation, such as swimming, learning purposes, fishing and sailing?

   X Very often during our leisure time
   - ❑ I do not use it at all
   - ❑ Undecided

8. Are you willing to accept policies that protect the water ecosystem services even if it will cost you extra expenses?

   X **Yes,** I am willing to accept and pay
   - ❑ **Yes,** I am willing to accept but I do not want extra payment
   - ❑ **No,** I am not willing to accept
   - ❑ **Undecided** or I do not care

9. How much would you be willing to pay (assuming you already pay **10Kr/ m^3**) for investing in water as an ecosystem service?

   - ❑ 15 kr/m^3

   x 20Kr/ m^3
   - ❑ 25 Kr/ m^3
   - ❑ 50 Kr/ m^3

10. Are you willing to accept the changes and inconveniences it might cause you due to improving and protection of water ecosystems?

    X **Yes**, I accept
    - ❑ **No**, I do not accept
    - ❑ Undecided

11. Please kindly state why you are willing to pay such an amount for the option(s) you choose above.

I am willing to pay for real improvements. Not for changes that might look good in government papers, but increase the environmental burden. An example of this is the ignorant assumption that combined sewers taking care of polluted storm water must changed to a system that has a much worse environmental impact.

Section D:

For a better understanding of your opinions, please kindly answer the following:

1. Age: ___45_____

2. Gender: x male female

3. Marital Status: single x married divorced widowed

4. Highest Level of Education: elementary school
 secondary school
 trade/ technical college
x university degree
 post-graduate degree

5. Occupation: retired
 unemployed
x employed – please specify ___water engineer

6. Total Annual Household Income:

x

Do not write your name on the questionnaire. Thank you for your time.