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Cost-Benefit Analysis of Wetland Alternatives on Vege River, Sweden

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Abstract

This thesis is designed to conduct a Cost Benefit Analysis (CBA) for wetland development project on Vege river in Southern Sweden. The objective of this thesis is to depict cost and benefit relationship for proposed wetland alternatives and to investigate the socio-economical feasibility of Vege river wetland project to overcome nutrients emission problem.

Using estimations of monetarised and non-monetarised benefit values and their comparison to the cost values specific to Vege wetland, the CBA study concludes that Vege wetland development can be socio-economically profitable if one considers the increasing potential value over the time. Most of all, this is relevant to nutrient reduction as well as with respect to recreational benefits for the society.

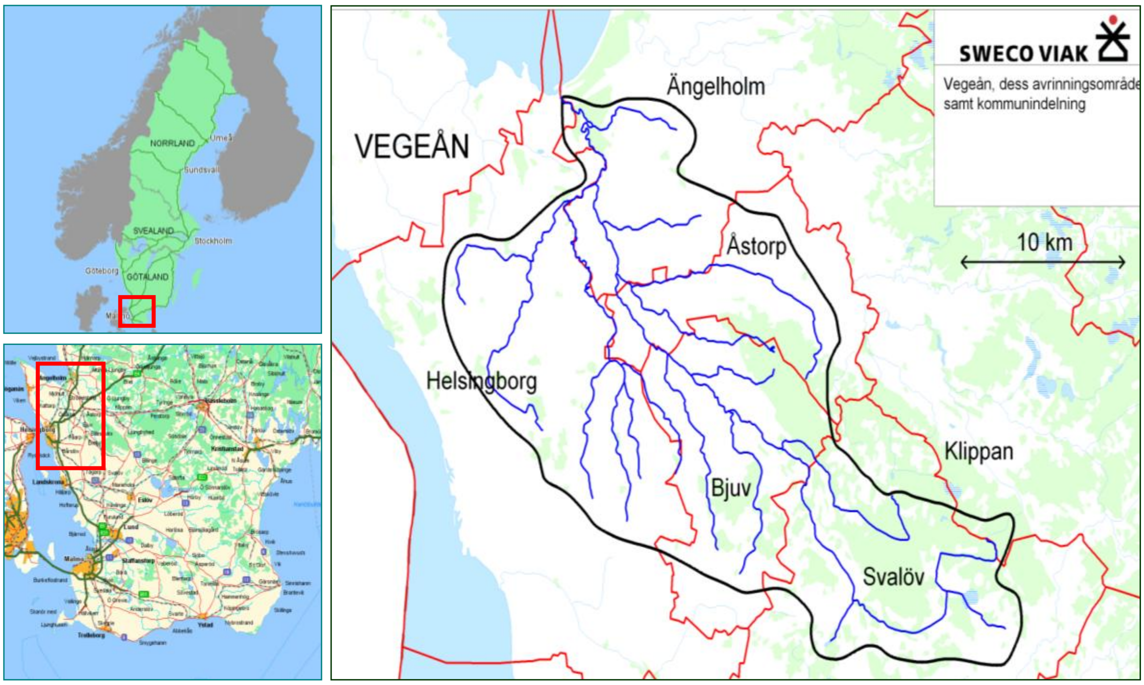

Figure 1 The catchment area of Vege river in Southern Sweden
Source: *Sweco Viak AB, 2007; Searching engine Hitta.se*

Key words: Cost-benefit analysis, economic valuation of environment, economic/financial analysis, Willingness to pay, wetlands as nitrogen and phosphorous reduction measures, Water Framework Directive.

Foreword

This thesis work was carried out in 2008. However, it is published in 2010 on the grounds of professional activities which led to a time shortage.

This thesis work would not be possible without overall support of many people involved to whom I would like to address my acknowledgments.

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Ani Shamyan

List of Abbreviations

CBA	Cost-Benefit Analysis
CE	Choice Experiment
CVM	Contingent Valuation Method
DF	Discount Factor
DRM	Dose Response Method
EQO	Environmental Quality Objectives
EPA	Environmental Protection Agency
EU	European Union
HPM	Hedonic Pricing Method
MAC	Marginal Abatement Cost
MB	Mitigation Behavior
MWTP	Marginal Willingness to Pay
N	Nitrogen
NPV	Net Present Value
OC	Opportunity Cost
OECD	Organization for Economic Co-operation and Development
P	Phosphorous
RBD	River Based Districts
RP	Revealed Preference
SEC	Swedish Environmental Code
SEK	Swedish Kronor
SP	Stated Preference
TEV	Total Economic Value
TCM	Travel Cost Method
UN	United Nations
USD	United State Dollars
WFD	Water Framework Directive
WTA	Willingness to Accept
WTP	Willingness to Pay

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1 Introduction

The significance of water and its distinct features for human and biodiversity, agriculture and industry, household utilizations is crucial. Almost all of these activities require fresh water. On the Earth, 97% of water resources are salt water, and only 3% is fresh water. Out of this 3 %, 68,7% are frozen in glaciers and polar ice caps, 30,1% is groundwater sources, 0,3% is surface water and other 0,9% freely fluctuating in the atmosphere and in the plants. Only 0.9 % of all fresh water sources on the Earth possible to use by humans (U.S. Geological Survey's, 2006).

As we know, fresh water is a renewable resource steadily decreasing because of the increasing demands on fresh and clean/treated water supply, growing population and income, as well as water pollution reduction. Thereafter, the economic analysis in form of Cost-benefit analysis and economic valuation of water resources became more and more relevant to cope with emerging water management issues.

The specific focus of this study is Vege river and its euthrophication problem caused by agricultural and industrial activities. To overcome this ecological imbalance and reduce nitrogen emissions in Vege it is purposed a wetland alternative to be developed at the lower Vege. How efficient and economically sounding this solution can be for the society or the municipality is considered to be discussed within this thesis.

This particular study will try to answer the research question on economic reasonability of the wetland development project comparing social costs and benefits of the wetland project. It will begin with the description of the institutional and governmental authorities who work with EU Water Framework Directive (WFD) and Swedish Environmental Quality Objectives (EQO) to lead the process with attaining national interim targets. Afterward, the chapter on Economic Theory will take over and provide with necessary background information on economic principles, valuation and CBA. The chapter on Case Study will give overview of the water pollution in Vege river and wetland measure possibilities. Here, purposed three wetland alternatives will be described. Thereafter, the Chapter on CBA for Vege river wetlands will depict the entire CBA process specifically performing for Vege wetland alternatives providing with key information, figures and assumptions. Here CBA proceeds by estimating and comparing monetarised and non-monetarised benefit values against the cost values. It is worth to mention that monetarised benefit values are estimated using economic valuation methods or benefit transfer methods form the relevant local wetland projects such as nitrogen and phosphorous reduction costs, recreational interest value. All relevant non monetarised values are incorporated into this study such as biodiversity numbers and better hunting/fishing possibilities. Cost arranging factors comprise of constructional, administrative, land lease and maintenance costs. Additionally thesis gives valuable information on potential investment sources for wetland development projects in Southern Sweden.

Additionally, the study makes interesting discussions linking nature valuation data and decision making process in environmental policy disciplines. In the end of the study conclusions over the economic reasonability of the development of Vege river wetland alternatives will be provided.

1.1 Background

Vege river is situated in north-western part of Southern Sweden – Skania (Skåne) and drains into Skälder Gulf and Kattegatt. The catchment area of the river is 496 km^2. The biggest tributary streams are Halla, Billesholm, Bjuv, Humle, Örja, Hasslarp and Skave. The Vege river catchment mainly involves Svalöv, Bjuv, Helsingborg, Åstorp and Ängelholm municipality areas (See Map 2). The total population number in the area calculated to be 42100 persons in 2000 (ALcontrol, 2006) which is slightly more than 40,000 persons registered in 1985 (VBB, 1985).

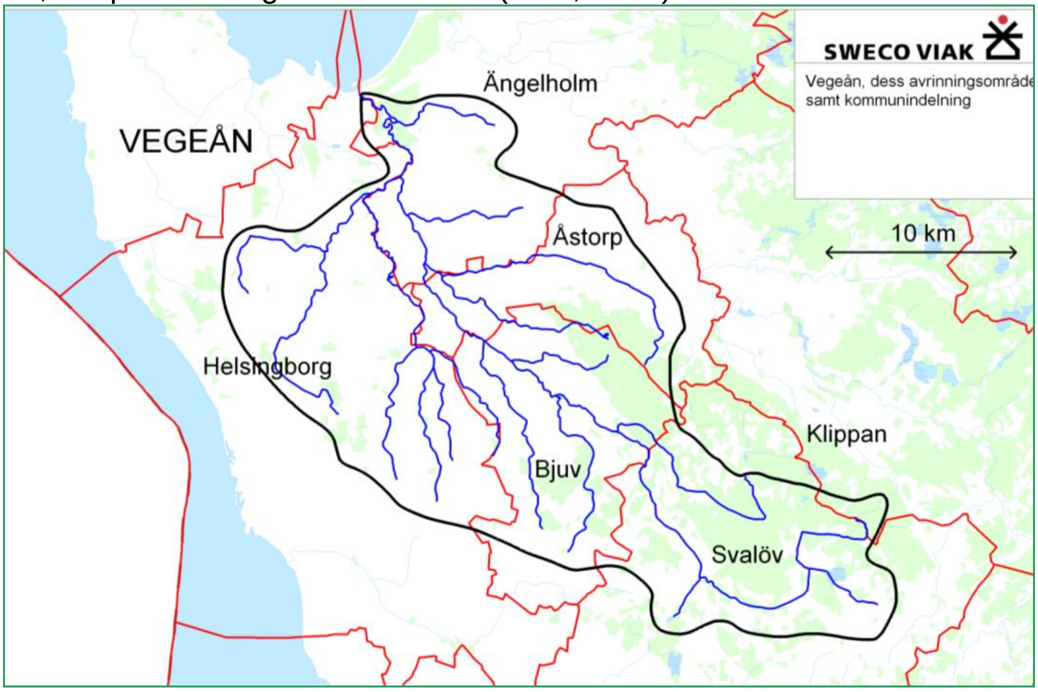

Figure 2 Vege river catchment area with municipally divisions
Source: Sweco Viak AB, 2007

Today, Vege river has euthrophication problem caused by agricultural and industrial activities in the catchment area. The drainage area is mainly dominated by agriculture (basically cultivated lands) by 63% - the largest portion out of which belongs to Hasslarp tributary area (ALcontrol, 2006). Furthermore, there are five sewage disposal sources and a few industries (Förlin L., 2006) that release waste water into Vege river.

To undertake a proper control over Vege river, since June 1968, local river association – Vege River Association (Vegåns Vattendragsförbund) commenced to supervise water management and utilization issues (VBB Viak, 2001). In this regard, a recent study conducted at the lower Vege river suggesting that the heavy nutrient pollution problem made water quality as poor as its biological, chemical and hydro-morphological features are deeply destabilized at the most parts of Vege river. Aiming to decrease the pollution level in the water and thus to achieve better ecological status for Vege river, a wetland alternative was chosen as a nutrients reduction possibility. This option is highly recommended by EU Water Framework Directive (WFD) and by Swedish Parliament by its Environmental Quality Objectives (EQO) adopted in1999.

EU WFD came in force in 2000 as a new EU water policy aiming to protect and improve Europe's water. The reason is that intense pollution impact, overfishing and physical exploitation of these areas need to have a better control today. As for Sweden, EU WFD is seen as an important international commitment and a tool to reach national EQOs.

1.2 The objective of the study

The main objective of this study is to make an economic assessment for wetland alternatives on Vege river watercourse applying Cost Benefit Analysis (CBA).

Within this, it aims to determine whether the wetland solution is an economically feasible option to overcome the water pollution problem in Vege river. It equally considers observing whether CBA is an appropriate tool to determine the economic feasibility of any wetland development projects.

1.3 Research question

Is it economically feasible to develop wetlands as nitrogen and phosphorous reduction measures on Vege river?

1.4 Assumptions

1.4.1 Time Frame and the Discount Rate

The economic time frame for the wetland is assumed to be 50 years. The discount rate is assumed to be 4 % for benefits and costs over time.

1.4.2 Number of biodiversity

To indicate the number of biodiversity that will reside in Vege river wetland area a similar wetland project need to be identified. Kävlinge river project started in 1995 and will carry on until 2009 aiming to create 300 ha of dam/wetland areas within the catchment area. The idea of this project is to control the environmental pollution of watercourses and lakes, to minimize nutrient transport to the sea for the benefit of biodiversity as well as people. Kävlinge river catchment area is 1200 km^2 and located in Southern Sweden. It is dominated by agricultural lands by 61%.

In 2004, there were introduced 97 dams (142 ha). Biodiversity inspections in 26-28 dams revealed that mean numbers were followings:

- plants - 30 species per dam,
- aquatic fauna (i.e. fish, amphibians) – 36 species per dam,
- birds - 15-18 species per dam, including threatened and vulnerable types.

These figures can be roughly generalized and transferred for Vege river wetland alternatives to make a general assumption on biodiversity numbers (Nysröm P., 2008, January 30, Personal Interview). Even though it is observable that Kävlinge river catchment area is much bigger than it is for Vege river (492km^2) it is still possible to transfer biodiversity numbers from one case to another. The key issue for species that will migrate from one site to other is certainly the quality of the environment and not the area factor of the wetland (Nysröm P., 2008). These numbers from Kävlinge river project are going to be applied as indicating figures for Vege river wetland alternatives.

2 Methods and Materials

2.1 EU Water Policy and Water Management Issues in Sweden

This chapter is going to focus on EU's water policy with specific emphasis on Sweden. Primarily, it is important to mention about the Ramsar Convention on Wetlands, as an outstanding progress of international community in water resources management. The official name of the treaty is *The Convention on Wetlands of International Importance especially as Waterfowl Habitat.* Ramsar convention on wetlands was signed in 1971 in Iran as an international treaty to enforce the conservation and wise use of wetlands and their resources (Ramsar, 2002). The preservation of wetlands and their resources and aquatic ecosystems are the important focuses of this international treaty. Sweden, along with other European countries, is a member to Ramsar convention. Since 1975 it is a member to the convention and has 51 Ramsar's area in its territory (Ramsar, 2002).

In regional level, new EU Water Framework Directive aims to protect Europe's water as many of its coastal and sea areas are intensely impacted by pollution, overfishing and physical exploitation (EU WFD, 2000). As just another step taken by Europe to protect its water resources it began with legal standards from 1975 and with binding quality goals for drinking water from 1980 (EU WFD, 2000). In 1991, Drinking Water Directive and Urban Waste Water Policy were the results of Frankfurt Ministerial seminar to make improvements for ongoing water legislation to protect the water from urban and agricultural pollutions by law.

Another significant advancement in water management area for Europe was declared by Helsinki Rules on the Uses of the Waters of International Rivers. It was adopted in Helsinki, 1966, the Convention on the Law of Non-navigational Uses of International Watercourses, adopted by UN in 1997 and Dublin Statement in 1992 (Lidèn, 2006).

A very specific role within EUs environmental policy has the Amsterdam Treaty which came into force in 1999. It develops essential rules for environmental protection and impact approaches stating that environmental impacts shall be integrated in the development and execution of politics also within other sectors. This agreement emphasizes the necessity to take into account the potential benefits and costs and environmental impact analysis related to any kind of environmental actions or lack of undertakings (Frykblom P., et al, 2005).

Although the considerable progress in EU environmental policy at that stage, the public awareness of citizens and other stakeholders, as well as water policy and water management problems coherent addressing way were not adjusted properly. Thus, in 1996, a new piece of legislation accepted by European Parliament at EU Water Conference. Here, open discussions and consultations held among interested parties on water policy and management issues stating that existing EU Water Policy was fragmentized in terms of its objectives and means (EU WFD, 2000). Thereafter, new EU WFD emerged to resolve mentioned problems with the key aims to (EU WFD, 2000):

- Expand the scope of water protection to all waters (i.e. surface water and groundwater). By this target it is supposed to realize the best model of water management by river basin instead of administrative boundaries. Therefore, for each river basin district a “river basin management plan” is expected to be set up and reviewed for every sixth year.

- Enhance "good status" for all waters, which is a general requirement for ecological protection and chemical standards, the identification of which based upon a set of procedures to be done on a given water body and to establish actual chemical/hydro-morphological water standards to achieve the criterion. The key objective for this is a general protection of aquatic ecology, specific protection of unique and valuable habitats, protection of drinking water resources, and protection of bathing water.

- Water management based on river basins reveals the requirement to set out all the elements of the analysis in a plan for the river basin, which is actually a detailed description of how the objectives set for ecological, quantitative and chemical statuses and protected area objectives are going to be implemented on a particular river basin. The plan will include information about basin characteristics, anthropogenic impact on the water, legal effects on management plan, the existing “gap” to reach the objectives, economic analysis of water use in the basin to suggest discussions on different measures and stakeholder participation issues.

  As the Dublin Statement on Water and Sustainable Development points this out the integrated management of river basins provides the opportunity to safeguard aquatic ecosystems, and make their benefits available to society on a sustainable basis (INPIM, 2003).

- "Combined approach" of emission limit values and quality standards by uniting and coordinating the application of different legal directives on pollution prevention from different sources (i.e. industry and agriculture) with full implementation of all existing legislation is considered. The quality standards assessment therefore can meet scientific limitations in regard of the dose-response relationships and mechanical transport of some substances within the nature. Thus, it is important to apply all existing technology-driven source-based control measures by consideration of their cost–effectiveness, and in case if the methods taken on the pollution source are not sufficient, take into account the additional measures to reach EQO.

- Getting prices right involving the implementation of the “polluter pays” principle (Naturvårdsverket, 2003). EU WFD requires economic analyses as one if the first steps towards recovering the cost of the necessary measure from the water users. It can be interesting to mention that some of users are not willing to spend money on water “fees”.

- getting the citizen involved more closely (see more at Public Trust and Participatory approaches)

- stream lining legislation

In recent years, a legal concept of “public trust” introduced to EU policy comprising the must to be of special concern to “pre-damage” initiations if a change has been made to natural resources and the environment. There are existing two versions of “public trust” (Brouwer R., Pearce D., 2005) requiring the followings:

1. Restoration of the natural resources and environment to its original or pre-damage situation;

2. Replacement of one asset by another asset to compensate the loss of the first one, in case if it cannot be restored.

For proper adjustment of public awareness in water policy and management it is necessary to develop a coherent addressing way. In this concern, the participatory and public trust issues need to be highly considered from economic viewpoint. It is because the lack of public participation in decision making process may oppose serious difficulties to the project or political decisions implementation which costs to call off (OECD, 2006). Therefore, as the same source suggests, having the public as an important stakeholder and participatory group is beneficiary. It is because that the public can support in producing better and improved project plans, being the most affected and closer side by decisions. In fact, CBA is based upon principles that are recording and assessing public preferences on various product/service choices. Hence, it is necessary to consider the public attitudes, preferences, and willingness to pay for particular goods or services.

2.1.1 Water Framework Directive and Swedish Environmental Quality Objectives

To overcome euthrophication and pollution problems and improve the control over the pollution, new and forceful environmental instruments are needed for nature protection in Sweden. Thus, in 1999, Swedish Parliament adopted 15 national Environmental Quality Objectives (EQO) to be reached by 2020. In November, 2005, the 16th addition has been included. As Environmental Objectives Portal, 2007, mentions, EQOs create a transparent and stable framework for environmental initiations and guide the relevant activities. Nevertheless, each of these 16 objectives is assigned to relevant state bodies to control and implement. EQOs related to water quality are the responsibility of Swedish EPA with an exception of Geological Survey Sweden for issues related to groundwater.

Thriving Wetlands Objective (EQO 11th objective) is one of water related EQOs for aquatic ecology protection. The outcomes of this objective will be the preservation of wetlands against drainage, peat extraction, road construction and other development operations, its recreational value and the biological diversity and cultural/historical assets. Nevertheless, it is the interim target of Thriving Wetlands to establish or restore at least 12,000 ha of wetlands and ponds on agricultural lands by 2010 (Environmental Objectives Portal, 2007). Another interesting point is that a decision making process needs to increase the public awareness on the significance of wetlands and biodiversity conservation issues as a key factor (Environmental Objectives Portal, 2007). An example of EQO measures can be that landowners must be encouraged to create and/or restore wetlands (Regeringskansliet, 2006).

Another supportive objective provides Flourishing Lakes and Streams Objective (8th objective of EQO) bringing out a goal for lakes and streams to have a good surface water status. That includes biodiversity, chemical and physical conditions in accordance with WFD (Environmental Objectives Portal, 2007). This particular EQO emphasizes the need to reduce nutrient inputs and pollution levels at the point that will not have any adverse effects on biological diversity. The next concerning EQO is “Zero Euthrophication” which has to be attained its quality targets by 2010.

According to Swedish Ministry of Environment, 2006, one significant change with new EU WFD is that the focus on water protection and management implementation issues will be based on river basin districts (RBD). Given this, it is compulsory to adopt a holistic approach for water protection and its use and to review the water management organization in Sweden (KSLA, 2006). In financial matter, for WFD targets it was proposed a governmental grant for SEK 50 million in 2005, which increased up to SEK 70 million by 2006 which said to be less than it is required by WFD.

The water quality regulation bodies are responsible for the control over the water authorities dealing with water at their respective water districts. In Sweden, there have been defined 5 RBDs (see Map 3). Every RBD evolves group of counties but has one central County Administration board (Vattenmyndigheterna, 2006):

1. Bottenvikens RBD which includes Västerbotten and Norrbotten counties. The central county administration board is Norrbotten County.

2. Bottenhavets RBD which includes Uppsala, Västmanlands, Dalarna, Gävleborg, Västernorrland, Jämtland and Västerbotten counties. The central county administration board for this RBD is Västernorrland County.

3. Norra Östersjöns RBD which includes Stockholms, Uppsala, Södermanlands, Örebro and Västmanlands counties. The central county administration board for this RBD is Västmanland County.

4. Södra Östersjöns RBD which includes Skania, Blekinge, Jönköping, Östergötland, Kalmar, Gotland and Kronberg counties. The central county administration board for this RBD is Kalmar County.

5. Västerhavets RBD which includes Värmland, Halland, Västra Götaland and Skania counties. The central county administration board is Västra Götaland County.

Figure 3. The map of Swedish River Based Districts
Source: Vattenmyndigheterna, 2006, available at:
http://www.vattenmyndigheterna.se/vattenmyndigheten/Om_vattenmyndigheterna/

WFD procedures are planned to be realized according to 6-year planning cycle with its five stage focuses (See Figure 4). According to Vattenmyndigheterna, 2006 those stages are specified as those:

1. Analysis and mapping
2. EQO and standards
3. Action programs
4. Implementation
5. Follow up and monitoring

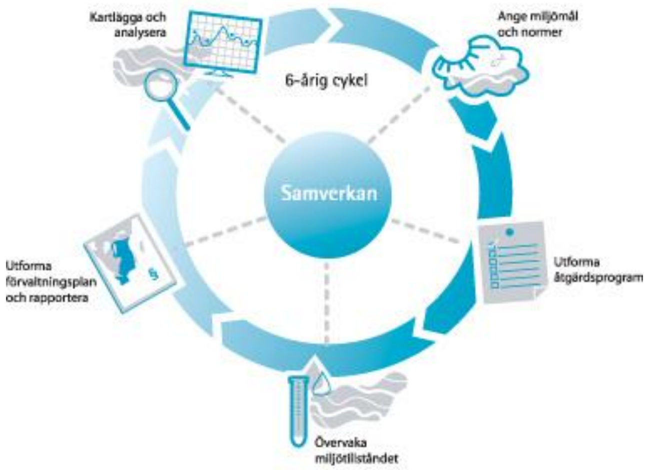

Figure 4 The illustration of different stages of WFD 6-year planning cycle
Source: Vattenmyndigheterna, 2006,
http://www.vattenmyndigheterna.se/vattenmyndigheten/Om+vattenforvaltning/Vattenplanerings-_cykeln.htm

2.1.2 Water Framework Directive Embedment into Current Administrative and Legislative Systems Facing Limitations

Currently, the central political system of Sweden certainly recognizes that EU WFD is a crucial tool in reaching national environmental targets. Therefore, Sweden is actively engaged in progressing and implementing WFD as an important international commitment. Currently, WFD has been only partly introduced into Swedish Environmental Code through Regulation on the Administration of the Quality of Water Environment.

As regulations over the nature use state, to take an action or intend to take any measure against the nature a person shall possess knowledge base necessary to view nature and scope of activities to protect human health and the environment against any damage that the activity may cause (Swedish Environmental Code, 1999, Ch.2, Sec.2). Another aspect of it is to take into account the particular importance of the benefits of the protective measures and other precaution. The cost-benefit relationship shall be taken into account in assessments relating to total defense activities or where a total defence measure is necessary (Swedish Environmental Code, Ch.2, Sec.7).

Although Swedish Environmental Code defines important regulations to protect environment, it still faces difficulties to cope with EQO implementation. Statuses and implementation measures of EQOs, that need to be enforced by law, are still uncertain, mentions KSLA, 2006. The probable reason of this is the contradictions between Swedish Environmental Code and Building and Planning Act, as well as overall uncertainty when it will be clarified (KSLA, 2006); or possible difficulties in form of political and legislative gaps limiting EQO implementation in water resources management. For example, according to current Swedish Environmental Code, agriculture and forestry sectors are of national interests (Swedish Environmental Code, 1999, Ch. 3, Sec. 4). This means that any action or intended measure realizing toward natural resources in Sweden need to be prioritized by national interests of Sweden. Besides, it can mean that this particular section of legal entity can be a restraint for some EQOs, such as for Thriving Wetlands EQO. As to remind, this EQO targeting at least 12,000 ha of wetlands and ponds that needed to be established or restored on agricultural lands by 2010.

Another limiting factor is that the responsible authority for WFD decision-making is not assigned yet. Therefore, Swedish environmental authorities at different levels (See Appendix 8.1) are in current disagreement “to whom should be given that authority”.

Despite of these obstacles, it is thought that WFD target reaching deadlines are thought to be short. In case of Vege river even if protective measures to reduce discharge levels in Vege river to be implemented, reaching good ecological status for Vege river (as for any other similar river in Sweden) according to WFD target-reaching deadline requirements on 2015, 2021 or 2027 may not be possible (Liden R., et al, 2007).

2.2 *Economic theory*

2.2.1 The role of economic valuation in decision making

The economic valuation practices can often support a sustainable use of natural resources in development decisions. In particular, it is an influential practice providing with quantitative values of resources and their services that do not have their market price, for example wetlands and their services. Economic valuation also assists to make wise decisions in regard of the use, management and allocation of natural resources. It also outlines those countless benefits from nature that increase human welfare at no cost in local and global scales. Economic values of those benefits are measured in terms of what we are willing to pay for their existence.

2.2.2 Basic principles of environmental economics

Economics considers the allocation of scare resources such as land, labour, natural resources and capital categories. As Turner, et al, 1994 notes, the scarcity of resources applies to the rate of the resource depletion and its total amount that can be consumed. As the quantity/amount of renewable resources (i.e. water, timber) is a relative category in a way, it is important to use them in more sustainable manner. It is to assure that they will not become non-renewable resources by time if to be used at rate higher than their natural capacity to replenish back. As Economist, 2007, reveals the “scarcity” in economic terms means that “needs and wants” exceed the resource availability to meet them. Furthermore, Ricardian (after David Ricardo - British economist) perspective says that the resource depletion is going to increase the cost and material prices for extraction organizations to dig out resources from the lower grade deposits (Turner et al, 1994). However, Malthusian (after Thomas Robert Malthus – British economist) concept of “limits to growth” opposing to this saying that people have to exploit as less resources as possible because the prediction of the absolute physical scarcity of natural resources in near/medium-term future.

However, one could argue that the scarcity issue for drinking water is more related to its allocation specifics around the world originating conflicts among different stakeholders or sectors that use the fresh water. In any case, for a decision-maker to be able to assign water resources inter-sectored optimally it is necessary to have results of the economic evaluation for water through non-market methods (Brouwer R., Pearce D, 2005). An example of this kind of challenging issue can be to decide on water resources allocation from agriculture sector to water preservation in nature instead. This type of decision will certainly make sure the long-term perspectives of fresh water conservation and its future accessibility for the next generations. In the aspect of conflicts on water rights, the economic valuation is getting more and more actual to assess different public proposals for water management (Brouwer R., Pearce D., 2005).

Natural resources, such as rivers and wetlands, do not have their market price and are known as non market goods. These resources, are getting their economic value from the purchaser and/or user’s preference and willingness to pay (WTP) for them rather than to live without them when they will get scare (Brouwer R., Pearce D., 2005). Willingness to Pay is the maximum amount of money that people are willing to pay for an improvement of a certain good/service. Willingness to Accept (WTA) is the minimum amount of money that one accepts as a compensation for a reduction of goods/services. WTP (and to some extent WTA) are widely being applied to conduct CBA studies.

This brings us to the utility or individual welfare term which is a measure of satisfaction of an individual (Economist, 2007). Precisely, under these circumstances individuals are setting a price to a certain non-market goods in ecosystem valuation studies. The price for a non-market resource is important as prices create basis to allocate resources in a manner consistent to a water consumer and allocative efficiency. The allocative efficiency is obtaining the most consumer satisfaction from available resources to maximize net benefit attained through their use (Environmental Economics Glossary, 2007).

According to Brouwer R., Pearce D., 2005, the applied national policy is that "decision implies valuation". In this concern, it is important to have a consequence prognosis of a decision. However, the market prices for water are not significantly affecting the decision on the resource allocation, which is because of the limited role that market price can play in an allocative role. Moreover, one reason of this can be connected with the shadow prices (Brouwer R., Pearce D., 2005).

An important principle that is going to be considered within the basic principles of the economics is the equity. It is tied up to the distribution of wealth in a society. If the wealth of the society is distributed fairly, then the efficiency criterion is useful. However if the wealth is distributed unfairly, then the efficiency may be too narrow to discuss (See Appendix figure).

2.2.3 Water Consumption in Economic Analysis

Water has its vital significance not only for human consumption but also for agriculture, industry and household utilizations. Because of its importance water is being subsidized by their governments in many countries. In long term perspective, the population growth and constantly increasing demand on water suggest the necessity to involve more and more financial means to cover up supply costs for water and to calm water crisis in various countries (mostly densely populated areas). Beside this very important role that subsidy carries (paid by tax payers), sometimes it is seen as some kind of "right" of the society "balancing" the opinion that charging for water is unethical (Brouwer R., Pearce D., 2005). However, water costs to supply and the resources that are invested to supply water can be used to supply something else. In that sense and therefore, economists seen the water as an economic good (Brouwer R., Pearce D., 2005).

Although the theoretical foundation and applied methods of economic valuation for non-market resources allocation are greatly advanced, they still lack developed valuation techniques to estimate economic benefits for non-rival or public goods such can be crop irrigation, hydropower electricity production and industry water uses (Young R.A., 1996). In the consumptive market non-rival are goods if its user do not prevent the enjoyment of others from the same goods, for example water or air uses. Usually, private organizations are not interested to supply such goods as it is not easy to exclude non-payers or free riders from the consumption. The core problem is that the exclusion cost demands to keep away those consumers who are not entitled from water use. As Young R.A., 1996 reveals, water unfortunately has a high exclusion cost because of its physical nature, when a water supply service exists for one consumer it cannot be excluded for another user.

Oppositely, a good or a service is known to be rival or private in the consumption market, if one consumer can preclude uses of the same good by others in some way. For the supply of those assets, sometimes there is a high competition among the supplying firms in the market (Young R.A., 1996).

As Young R.A., 1996, mentions there are different types of commodity benefits that are divided as the followings:

1. rival in use - personal drinking, cooking, sanitation, productive activities in farms and different businesses and industries;

2. in-rival in use - recreation, aesthetics, and fish and wildlife habitat;

3. use of watercourses or water bodies as a waste disposal “basin” for different consumers. The most important point here is the assimilative capacity of the water body, which as author implies has more public than private value background because of the free rider problem.

Another distinction of water consumption is its in-stream and off stream uses. In-stream or non-consumptive water use is a type of economic asset values of which is related to water consumption in its natural hydrologic environment. For example, water used for dams, waterways, hydropower production or water storages for irrigation or fire fighting uses such are ponds, wetlands, pools, etc.

The off-stream or withdrawal uses of water are the consumption types occurring out of the natural environment of water. The dis-values or negative benefits from the viewpoint of environmental economics naming flooded water amounts or the excess of pollutants are reducing the welfare of the society and oppositely, the reduction of those losses increases human welfare and benefits for the society.

2.2.4 Economic valuation of natural resources

The need for economic valuation of natural resources and their environmental services is important to pursue efficient decision-makings in policy and in project-prioritizations.

As it was described before, there are goods and services that do not have market price (i.e. environmental externalities) and therefore are not being sold or bought in the market. Moreover, market itself does not react properly on the price formation for non-market goods as it was mentioned before. However, as decisions made by authorities can affect the environmental assets in one way or another, they need to know the total value of assets for societies. Furthermore, for policy makers and various stakeholders to make a trade-off for an environmental asset, it is important to know what is being exchanged against what. Hence, it is necessary to assign a monetary value to a non-market environmental asset by knowing willingness to pay or accept principles for individuals, where the market fails to reveal this information (Turner, et al, 1994).

In the history of economics, different techniques have been developed to assign an economic value to an environmental goods and services. Though the term of total economic value (TEV) has been launched, yet it is important to remember that it is just a part of a total value of environmental goods and services. According to Schuijt, 2003, the total value of an environmental asset may consist of ecological value, an intrinsic value, socio-esthetical and economic values. TEV of non-market environmental asset provides an all-encompassing measure of the economic value of any environmental asset (Pearce, et al, 2006). As it is presented below, TEV is divided into Use and Non-use values.

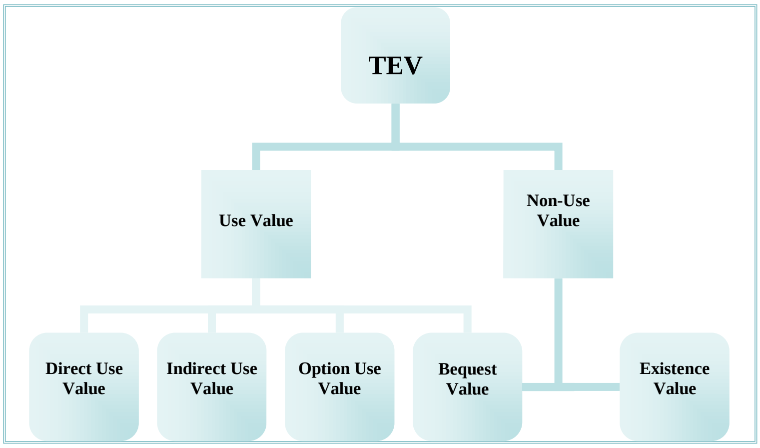

Figure 5 The total economic value (TEV) of a natural resource,
Source: Turner, 1994

Externalities are costs or benefits occurred in the result of an economic activity that indirectly affects ones that are not engaged in that activity and not included fully in prices (Economist, 2007). Externalities can be positive and negative. They are positive if an action of one confers to; a) benefits to others and b) are caused by activities outside the market. For example, an activity that adjusted to improve the water quality (i.e. wetland creation) creates positive externalities causing benefits not only for the nature by improving the water quality and biodiversity condition but also for the societies by a better flood control capabilities. The negative externalities are costs to other party which are not considered on the market. For example, the nitrate discharges from an agricultural activity causes water clean-up costs for nearby living residents and environmental harm to nature.

Externalities are side-effects for a third party and are not reflected in the market price thus forming a market failure. Therefore, to improve the situation in order to support decision makers and other interested stakeholders; it is highly essential to incorporate external costs/benefits into market prices of goods and services, a practice that in economics is known as internalizing externalities (Harris, 2002). To include environmental externalities/costs into the product prices is based on Polluter Pays Principle. If the polluters do not pay, then the society as a whole will have to pay or share the burden. This is referred to as the Victim Pays Principle or sometimes as Society Pays Principle.

However, Society Pays Principle is not clearly revealing the use of natural resources by a consumer or tax payer, as it mentions Clean Air Act, 1990. In case of Society Pays Principle, environmental externalities are costs that should be paid by polluters themselves. For example, WFD suggests apply Polluter Pays Principle to protect water bodies from pollution. By that, farmers expected to be charged for per unit of contaminants that will be released into water body. Thereafter, farmers as polluters are going to take own responsibilities for their actions, as soon as the legal status of WFD will be certain in Sweden.

As many environmental goods do not have their established market prices, for example improved water quality, it is hard to identify those values. However, it is possible to estimate the economic value of the environmental goods or service in monetary terms through selectively applicable techniques. Those techniques are divided in two broad direct or demand curve approach categories (Dixon, et al, 1994):

- Revealed preference (RP) approaches or surrogate markets to determine the value of the good. This values of environmental goods being determined by mean of the price paid for another alternative goods having market price. In principle, the travel cost method (TCM) and hedonic pricing method (HPM) are two types of RP techniques that are known. HPM is applicable when people are pictured as valuing goods in terms of the bundles of attributes which these possess. For example, paying little extra for a house within the area of cleaner environment. TCM is being used to estimate demand curves for already existing recreational sites and thereby value those sites.

- Stated preference (SP) approach, which includes contingent valuation (CVM) or hypothetical valuation, choice experiment and contingent ranking methods. These techniques are useful for cases where markets for environmental goods or services do not exist, are not well developed or where it is not possible to value the effects of a particular project by surrogate market technologies.

The major difference between these two techniques is that PR reveals people behaviour but SP approach is more focused on people intentions. For an environmental goods and service such as "water quality improvement through the wetland solution", there is not a market where you can simply purchase or have information about the price of that service. Thereafter, CVM, as one of the Stated Preferences techniques of CBA is going to be applied to estimate economic value for this "product". CVM is one of the advanced economic valuation methods involving questionnaires which directly bring out the individual's WTP/WTA for changes in provision of non-market goods. It is largely relies upon the individual's valuation of natural resources through WTP or WTA measures. CVM requires direct questioning of consumers to decide their reactions on a certain change in a situation. There are various CVM techniques and the most common way to do CVM study is to implement interviews. It is when a researcher interviews various households either at the site face-to-face or via telephone or mail means (Hanley, et al, 2001).

CVM starts with the individual and his/her perception of a change in environmental goods or services. Because individuals are hurt or benefited by any change in environmental goods/services, their answers will have a relevant impact on the valuations of recourses, suggested by CVM, and will explore differences between WTP and WTA.

Although this, WTA and WTP estimations may lead to specific complexities. Empirical evidences are revealing that WTA compensation far exceeds WTP for any goods for which individuals have legal property rights (Dixon, et al, 1994).

This detail has strong psychological roots and is not well explained in the theory. It is the fact of the ownership that leads individuals to put much higher value on a certain item than they are actually ready to pay for it in the other circumstances (Kahneman and Knetsch, 1992). However, as the same source also states, WTA should be used when individuals are forced to renounce something or suffer some damage.

By inferring the individuals' choice expressed during the questioning may not always give accurate approximations. It is mentioned, however, that the method will deduce a valuable order-of-magnitude estimates important for decision making (Dixon, et al, 1994).

If a valuation method cannot be used in a specific case benefit transfer is widely used in CBA. This method can be applied to estimate the economic value of ecosystems and their services, such as wetlands. It is done by transferring the completed survey results to the ongoing studies, preferably having relevant locations and contexts to the original one (See more in 4.3 Benefit Transfer Method).

Besides the direct valuation methods, there are also non-demand curve valuation methods known as Dose Response Methods (DRM), Replacement Costs (RC), Mitigation Behavior (MB) and Opportunity Costs (OC) methods. These methods do not value environment "directly" and do not provide "true" measures of value, but they do give helpful indications and information for policy makers (Turner, et al, 1994).

- DRM originates from the relationship between non-market and market goods. The cost of water pollution in the sea can be derived from its effects on tourism industry. An increase in algae growth in the sea water decreases its recreational and aesthetic value of beaches thus effecting tourism industry.
- RC studies the cost of replacing/restoring the environmental good, which is used as a benefit to restore that natural good. As Turner, et al, 1994, exemplifies, the cost of wetland relocation from one site into other can be used to value the economic benefits of the wetland preservation.
- MB looks at the relationship between environmental goods/services and their best possible replacement. For example, the benefits of wetlands N reducing service can be estimated by the cost of the catch crop cultivation measure that has been avoided.
- OC is a method to value the environmental goods indirectly considering the benefits of one harmful activity as an indication of a value another activity by preventing the harmful one. For example, the value of the agricultural activity causing river pollution would be a benefit estimation of water quality improvement, if the agricultural activity would discontinue.

2.2.5 Historical and theoretical backgrounds of Cost-Benefit Analysis

The origin of CBA theory roots from 1840s when French engineer and economist Jules Dupuit made his input into Economics and public choices about the investments with no necessary commercial returns (Pearce, 2002), such as construction of roads and bridges. He found ideas of such basic economic principles known as consumer's surplus, consumer's net benefit measured by the excess of willingness to pay over the cost acquiring the good. Actually, it is the change of the *consumer's surplus* that measures the benefits of providing more of a good (Brouwer R., Pearce D., 2005). Consumer surplus is the benefits that consumers receive from goods in excess of the amount they pay for it (Harris, 2002), for example if one uses wetlands capacity to reduce nitrogen amount in the water but do not pay for its water holding capacity or for its recreational value. However those surpluses may apply to goods regardless of whether they are market or public goods.

This particularly applies to water resources. It is mostly because of the water has competing uses and for some of those uses it acts very much like a private good, according to Brouwer and Pearce, 2005. For example, A's consumption is at the expense of B's consumption or A's enjoyment of water based on resources that does not affect B's satisfaction from the same water resources. If to look at the water resources from the economic efficiency viewpoint, it needs to be assigned to users who have the highest willingness to pay for water.

Historically, CBA of water resources had its essential focus on flood control issues, their costs and damages that could be prevented by flood control measures. Such CBA procedures are common in different countries, such as UK and Netherlands. By damages it can be stated those welfare losses for instance property, crop and construction damages, impacts on wetlands and health state in the flooded area. Therefore, the central tasks for CBA in this aspect are (Brouwer R., Pearce D., 2005):

- to progress "benefit–cost" ratios and reveal more potentials to prevent flood damages,
- to motivate the science predicting the flooding events;
- to enhance the discussion between the different stakeholders by "Benefits and Costs" thinking way to support the decision making processes.

The major theoretical foundation issues of CBA to be discussed here are benefits as an increase of consumer's wellbeing/happiness and costs as a reduction of that wellbeing/happiness. On CBA study grounds, the project or decision making considered to be qualified if the benefits exceed costs for individual or society. If we take this on the social welfare level then social benefits should "win over" social costs. (OECD, 2006).

The theoretical foundation of CBA comprises of:

- the preference of individuals that are to be considered as a source of value (i.e. preferring A to B as the welfare/ utility is higher);

- the preference are measured by WTP for a benefit and by WTA for a cost compensation;

- the assumption that all individual preferences are chosen to be summed up into social benefits and costs systems;

- if "beneficiaries" from the change can hypothetically compensate the "losers from a made change" and have some net gains left over, then the basic test that B exceeds C are met;

- Discount factor (DF)/ weight

$$DF_t = 1 \Big/ \left|(1+S)^t\right|$$

s- Discount rate
t – Time

In CBA, the issue of “who counts” or “standing point” is essential to be agreed. “Standing point” determines who is our main stakeholder in CBA study and from who’s point of view it is going to be conducted.

Along the standing point issue, other ethical problems might be involved to determine the aggregation rule applicable to geographical boundaries. For example, if A wealthier than B, then USD 1 to poor B will have a higher utility than it is for rich A. As Vege river flows within the geographical boundaries of Sweden ethical problems persist only within the country. However, the more “utilitarian” rule takes into account more income/wealth differences. The allowance for variations in the marginal utility of income is a method of equity weighting. (OECD, 2006).

Once interviewed people reveal or state a value for a resource. These values are aggregated into a total value, which certainly depends on the number of individuals being affected of the specific project.

Here, it is important to define basic aggregation rules. One of those states that the aggregation of the benefits within one society or different society groups is the sum of total willingness to pay (WTP) or to accept the compensation, WTA. If equity issues are taken into consideration higher importance should be given to benefits and costs that are accruing to lower income group. It is because that the marginal utility of the income (additional income excess) is much higher for the lower income group than it is for wealthier income groups. (OECD, 2006). The aggregation rule also works across the time as a discounted value for WTP or WTA, according to the discount rate. It is important that it represents accurately all of the value that people in the society place on the item. This means that there are no missing sources of value itself (Field, 1997).

2.2.6 Use of Cost Benefit Analysis in Sweden

The actual use of CBA in Sweden is highly depending on its embedment into the current legislation. Given to this it is interesting to see what different legal documents state about CBA and its use. The Amsterdam treaty (came in force - May, 1999, 174:3) mentions that when EU forms its environmental policy, it shall consider potential benefits and cost associating with undertaking or the lack of undertaking of actions. This does not necessarily argue that the consideration of benefits and costs of a project is applying to a monetary comparison of its effects by CBA, according to Frykblom P., et al, 2005.

As it was mentioned before, Swedish Environmental Code (Miljöbalken), that came in force in January, 1999, states that: “The rules of consideration in Sec 2 - 6 (for the areas of activity within – possessing a knowledge to deal with nature and a scope to protect human health and the environment against damage or determinant; implementation of protective measures (the best technologies) in order to prevent, hinder, combat damage or determinant to human health and environment; land or water area uses with minimum damage and detriment to human health and the environment; conservation of raw material and energy, reuse and recycle; avoid using chemical product or biotechnical organisms) shall be applicable where compliance cannot be considered unreasonable. The cost-benefit relationship shall be taken into account in assessments relating to total defense activities or where a total defense measure is necessary (Swedish Environmental Code, Ch.2, Sec. 7). As one can observe, there is not any clear indication of CBA requirement yet.

One of the key aims of new EU WFD, which came in force in 2000, discusses that water management based on river basins reveals the requirement to set out all the elements of the analysis in a plan for the river basin, which include information about basin characteristics, anthropogenic impact on the water, legal effects on management plan, the existing “gap” to reach the objectives and ***economic analysis of water use*** in the basin to suggest discussions on different measures and stakeholder participation issues (EU WFD, 2000). However, we again observe that the application of CBA as an economic analysis tool is not an explicit requirement.

A group of researchers assessed the actual and future CBA application by governmental and non-governmental organizations in Sweden. 38 organizations took part into the investigation and answered the offered questionnaires to see if they considered using CBA in projects, 1997-2001. In result, 3 groups were identified: Yes (10 st); No, but soon (3st); No (25st). One of the agencies that use CBA directly related to water issues is Swedish EPA (Frykblom P., et al, 2005). Other agencies that applied CBA are Swedish National Rail Administration, Swedish National Road Administration, Swedish Institute for Transport and Communication Analysis and National Institute of Economic Research. The Swedish Energy Agency, foresees CBA use in connection with 15 National Environmental Goals.

Today, CBA being considered as widely accepted procedure locally (sector adjusted) and internationally. In some countries, as in USA and Netherlands, CBA is fastened by national legislation and is an obligatory routine. In Sweden, CBA was and is extensively recognized procedure only for some sectors such as air and noise pollutions, traffic and road administration, public health and medicine development, etc.

In water resources area, however, CBA advancement is major today. To bring more insight into this issue, Table 1 organized briefly as a result of a survey to represent several CBA and relevant economic study examples conducted for wetlands and water resources for local and international markets.

Table 1 Examples of wetland economic valuations conducted in Sweden and abroad

Source	Name / Purpose	Method used	Results
	Local projects:		
Andersson J., et al, 2000	***Våtmark Oxelösund – resultat och erfarenheter från sex års drift (Oxelösund wetland – Results and Experience of 6 years of maintenance)*** Öxelesund wetland was created in1993 to remove the nitrogen in pre-treated municipal wastewater before it will reach the Baltic Sea. Along the monitoring and assessment studies, an economic survey has been conducted to know how much a person was willing to pay to preserve the Öxelösund wetland. Population number in Öxelösund counted to be 10.000 people.	CVM	170-370 SEK/person/one-time 1,7-3,7 mil. SEK/community

Byström O, 1998	***The Replacement Value of Wetlands in Sweden /*** The paper estimates the value of using wetlands for abatement of agricultural N load into Baltic Sea. The replacement value of wetlands is estimated for Sweden. It is shown that the use of wetlands as N sinks can reduce the total abatement costs of N emissions by 30% for Swedish agricultural sources of N pollution.	Replacement value	Total N abatement (50%) cost is 540 MSEK/year for 1800ton-N/year
Carlsson F., et al, 2002	***Valuing Wetland Attributes: an Application of Choice Experiment*s /** The study aims to find out which attributes of wetlands existence are good, besides the nutrient uptake. Found attributes increase or decrease the wetland value represented by WTP of community members. Conditional Logit Specification model was compared with Random Parameter model to analyse obtained results and find the greatest contributors to the community's welfare.	Choice experiment	The marginal WTP is higher for wetland attributes: - Biodiversity - Walking facilities The marginal WTP is negative for wetland attributes: - Fenced waterlines - Crayfish - Meadow land
EKOLOGGRUPPEN I LANDSKRONA AB, April 2004	***Höje river project: cleaner river is a richer landscape – Final report, I – III*** Höje river assignment is an environmental project done by the municipality of Lund, Staffanstorp and Lomma via Höje River Watercourse association in 1991-2003. With euthrophication concerns, the objective of this project was to reduce Höje river the transport level of nutrients to Öresund with 80 ton. This aim is met by establishing 80ha of wetland areas	Nutrients reduction cost	The average cost for all these ponds and wetlands amounted to 245 000 SEK / ha for 75.2 have wetlands, 16 SEK/kg-N. Assuming that an average nitrogen removal capacity is 560 kg / ha / year which implies a reduction cost of 31 SEK / kg N (based on 6% interest and an amortization period of 30 years).
EKOLOGGRUPPEN I LANDSKRONA AB, May 2004	Kävlinge river project: Project Directory stage II – Final Report The project is a program designed to reduce the transport of nutrients to the sea and for the benefit of the wild flora, fauna and people in the agricultural landscape in Kävlinge river basin. There are also cooperation agreements between the nine municipalities. Measure work has focused on the construction of natural ponds and wetlands. Overall in Stage I and II, 125 acres, divided into 97 ponds and wetlands.	Nutrients reduction cost	The average cost for all these ponds and wetlands is about 245.000SEK/ha The average nitrogen removal capacity is 600 kg per ha per year. This means a reduction cost of roughly 25 SEK / kg N (based on 5% interest and an amortization period of 30 years).

Gren I-M, 1994	***Cost-effective Nitrogen Reduction to the Stockholm Archipelago/*** The purpose of the study is how to reduce the load of nitrogen to the archipelago at its minimum cost. The wetland restoration option was chosen to reduce the nitrogen load sourcing from agricultural lands.	Constant operation al cost	20-60 SEK/kg-N-reduction
Gren I-M, 1994	***Benefits from Restoring Wetlands in Gotland/*** The purpose of this study is to overcome the environmental problem in Gotland the insufficient supply and quality of drinking water. It is being supplied by groundwater wells and containing high nitrogen level which in some cases exceeds 100mg NO3/l. Improved water quality valuation was conducted within Swedish population. 1000 people were asked to know their willingness to pay for a water quality improvement of no more than 50mg NO3/I as WHO recommends.	CVM	600 SEK/ person/year
Söderqvist T., 2002	***Constructed Wetlands as Nitrogen Sinks in Southern Sweden: An Empirical Analysis of Cost Determinants/*** The purpose of this paper is to improve the understanding of factors that influence wetland construction costs in practice. These empirical relationships between construction costs and their determinants are estimated to support specialists predicting total costs for N abatement through wetlands; cost effectiveness or CBA studies approaching N reduction issues. The study was based on two wetland construction programs in Skania in the catchments areas of Höje and Kävlinge rivers purposing to reduce the nitrogen transport to the sea, improve biodiversity and recreational potentials in the area.	Empirical cost equations	1. N reduction cost implies 2.15 USD/N-kg, if the average total cost is 2150 USD/ha/year and N reduction average as 1000 N-kg/ha 2. Or, total annual cost is 11.7 SEK for the area of 1.14ha
Löwgren M. et al, 2002	The Value of the Wetland A natural question for anyone considering the construction of a wetland how much it will cost and whether it is worth the cost. The design and size will vary depending on the purposes of the wetland establishment and thus determined the type of works needed.	-	5000 ha wetland would reduce nitrogen leaching more than 850 ton-N/year at a cost to society of 37.7 million or 44 SEK / kg N.

	International projects:		
Dubgaard A, et al, 2002	***Cost-Benefit Analysis of the Skjern River Restoration Project, Denmark /*** The original project proposal of the Skjern River project in Denmark expected to be 211 ton-N/year or 350 kg-N/ha/year. The institute has calculated that establishing wet meadows is one of the cheapest alternatives for society, when it comes to limiting emissions of nitrogen into the marine environment.	CVM, Benefit transfer method	The net present value of wetlands is calculated to be app. 35 million DKK, at a discount rate of 3% over an indefinite time horizon.
Georgiou S., et al, 2005	***Cost-benefit analysis of improved bathing water quality in the UK as a result of a revision of the European Bathing Water Directive*** ***/*** The focus of this paper is to conduct CBA of the EC bathing water Directive revision. In UK, there is a growing concern of the public health risks of sewage discharged into coastal marine waters are derived from human population infections. The study seeks to consider the issue of whether the revision is worthwhile in terms of the economic benefits of coastal bating water complying with it, or whether the resources required to afford compliance would be used more efficiently to achieve other goals.	CVM, WTP	Mean WTPs are: -Norwich: 54£/household/year -Lowestoft-35£/household/year -Great Yarmouth: 30£/household/year The total net present costs for the guideline standard use is estimated to be 2.2-4.8 billion £, based on prices in 2002, discount rates of 6 % over the 25-year time frame.
Meyerhof J. Dehnhardt A. 2007	***European Water Framework Directive and Economic Valuation of Wetlands: The restoration of floodplains along the river Elbe, Germany /*** This paper concerns the economic valuation of riparian wetlands ecological services within the European Water Framework Directive (WFD). It introduces economic analysis as a core part of the development of integrated river basin management plans. The study of the river Elbe shows that riparian wetlands provide significant benefits that should be considered in river basin management decisions. To neglect these benefits would lead to biased cost–benefit analysis results and might therefore misguide the decision-making process.	CVM, Replacement cost	The net present value of applied eight scenarios range €854-1074million. Moreover, Benefits- cost> 0 for all scenarios

Hunag J-C., et al 2006	***Economic Valuation of Beach Erosion Control /*** In this study, a choice-based conjoint survey design is applied to elicit individual choices of beach erosion control programs that can potentially cause multiple effects on beach environment. The purpose of this study is to derive welfare estimates that are adjustable according to individual heterogeneity and the varying effects of different erosion control programs. Two empirical choice models are used to analyze the elicited individual choices of erosion control programs. Results show that to a typical individual, both the positive and negative impacts of the programs affect his/her choices. It is found that the economic benefit of an erosion control program to preserve a stretch of sand beach can be overstated if potential negative impacts on the coastal environment from the same program are not considered.	Choice based conjoint analysis	The erosion control program has a value of: - 4,45$/household/year for 5 mile beach preservation -(-3,65)$ /household/year for only 1 mile beach preservation

* Source: http://www.ekologgruppen.com/KAVLINGE/default.htm

3 Results

3.1 Case study: Wetland alternatives to overcome water pollution problem in Vege river

3.1.1 Wetlands and their functions in nature

The role of wetlands in nature is well documented in various information sources by different authors. Wetlands are usually defined in terms of their physical, chemical, and biological characteristics such as hydrologic regime, soil type, and plant species composition (US Army Corpse of Engineers, 1995).

During early human history, wetlands served as sources for food, fiber and shelter supporting many communities and their generations. From wetland natural services benefit not only mankind but also different flora and fauna representatives such as fish, birds, amphibians and other wild life species keeping their existence due to favourable ecosystems generated by wetlands. In fact, wetlands are also known as natural systems that preserve biodiversity. (Tiner R, 1999)

Historically, as human development advances, cultural attitudes of people towards wetland values were changed. Those areas were often seen as “wastelands” (Tiner R, 1999) and were dried artificially to make a good use out of the land territory. Wetland destructions and river drainages were recognized as “solutions” in many countries where the agricultural development was a priority issue. For example in Southern Sweden, as a result of ditching, pipe and river channel drainages, strengthening of watercourses or lowering lake levels brought drastic changes to the agricultural landscape during last century. These changes, as Arheimer, 2002, discusses decreased the water residence time in the landscape and the potential for nitrogen reduction during its travel time in the freshwater.

Later, as natural environment declined significantly in forms of increased water pollution, number of endangered species, flooding events and poor erosion control and shoreline stabilization (Tiner R, 1999), reduced recreational and research opportunities and aesthetic values, people in different part of world began to recognize the essential role of wetlands in nature and their value. Today, wetlands are recognized as valuable natural resources that need to be preserved. In this concern, wetland (re-)creation attempts are highly approved around the world.

In the nature wetlands carry out various functions, from simple to complex mixture. The hierarchy of wetland function (See Table 12) reveals that wetlands functioning as nitrogen removal pools perform quite simple functions, while wetlands with biogeochemical and nutrient cycling considered realizing more complex functionality.

Wetland Functions and their benefits are listed in Appendix 8.3 Wetlands function and their value.

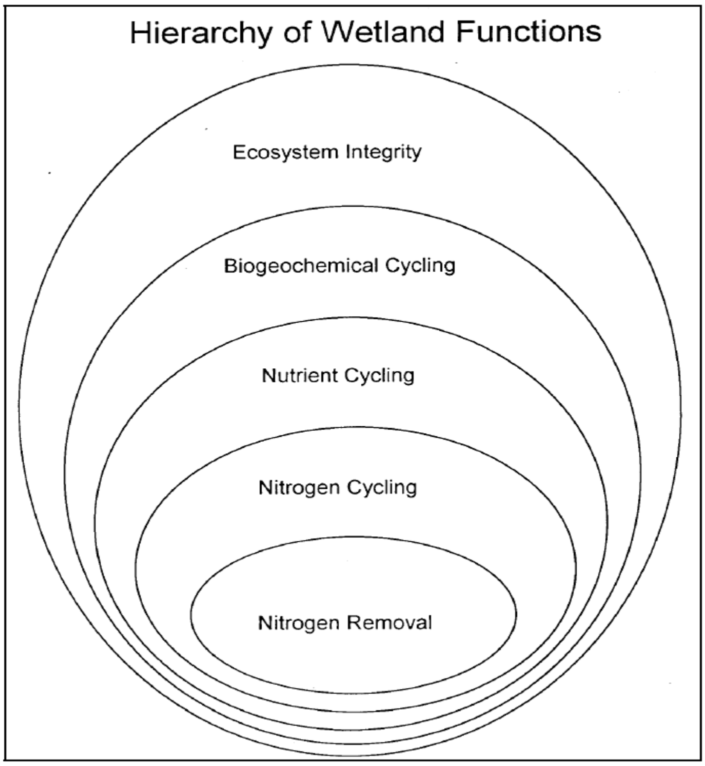

Figure 6 The hierarchy of wetland functions
Source: US Army Corps of Engineers, 1995

Although definitions, wetlands usually possess same hydrologic, soil and vegetative related features. In nature, features that wetlands can provide are the followings:

- **Water cleaning function** which gives possibilities to capture different types of pollutants such as nitrogen, phosphorous and other particles (Tonderski, et al, 2002). Specifically, inland wetlands, also rivers, lakes, ponds, marshes, perform freshwater cleaning function. Wetlands can trap sediments, nutrients, heavy metals and toxic materials, and reduce high level of nitrogen and phosphorous in the water associated especially by agricultural runoff.

- **Biomass production capacity** provides bio-energy and bio matter accumulation in the wetlands that are valuable goods for agricultural uses.

- **Water holding capacity** contributes to the inflowing and out flowing waters current variations. It also stores and cumulates the water in a wetland area which afterwards can be used by different purposes such as fire fighting or irrigation.

- **Biodiversity sustaining feature** helps to sustain various types of flora and fauna representatives depend on wetland environments. They are the most effective natural systems that sustain lives of numerous species. As EPA 2007 describes, it is the combination of shallow water, high levels of nutrients, and high rates of primary productivity in wetlands that makes it great for the development of organisms that form the base of the food chain.

- **Recreational and cultural value** of wetlands make available for different societies for outdoor nature experience, hunting, sport-fishing, bird-watching, ecotourism, beautiful landscape views, research and education possibilities.

3.1.2 Nutrient pollution impact on Vege river

Although all attempts to reduce water pollution in watercourses flowing to North Sea (i.e. Skälderviken), there are still remaining euthrophication problems and high pollution level of oil and toxic substances in the water that are signs of ecological imbalances of water (Ministry of Environment, 2006). In this regard, Vege river as a river draining into Skälderviken, Kattegatt has a considerable effect on the situation. Historically, the substantial increase in the anthropogenic load of nutrients in Vege river played a big role and led to ecological imbalance in the river and in the sea as an end result. Based upon the information on water quality measurements done by Findus AB in 1947-1950, Vege river became known as a river where normal biodiversity cannot be found anymore. In another source it was told that Vege river is one of the most polluted rivers in Sweden in 70's (Vegeåns Vattendragsförbund, 2007). In the Map 4, it is observable the division of polluted areas in Vege river catchments.

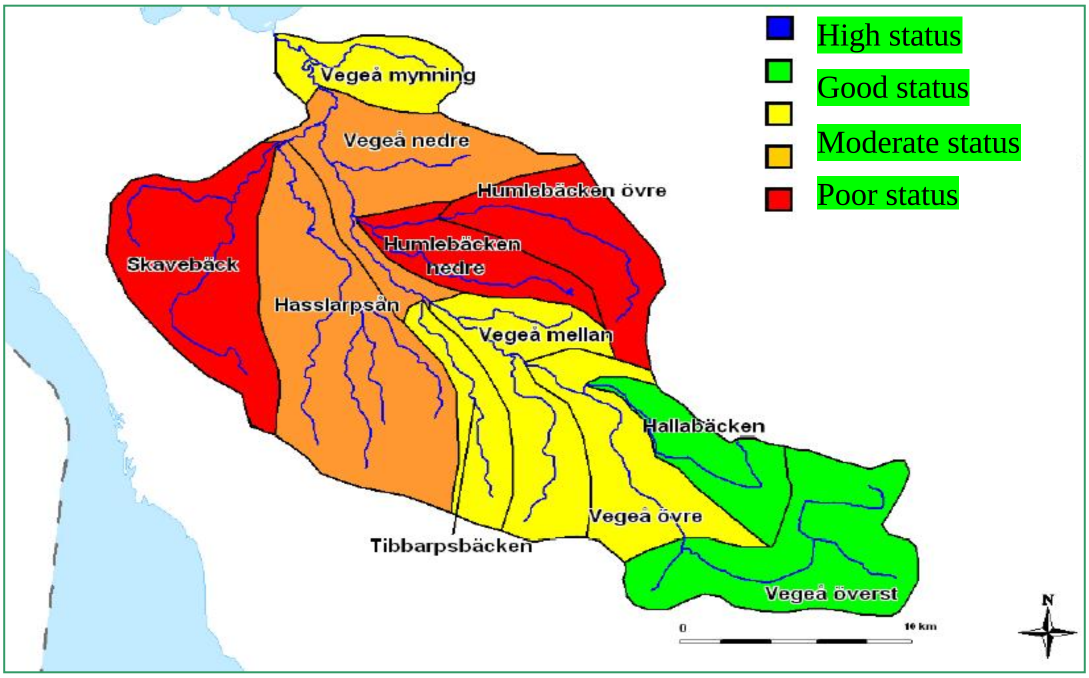

Figure 7 Distribution of the polluted areas on Vege river catchment area
Source: Förlin L., 2007.

To improve the water quality and have a better control over discharges taking place at Vege river watershed area, Vegeåns Vattendragsförbund considered various solutions during its activity time. Reduced use of fertilizers, creation of non-cultivated buffer zones along the most parts of the river course and the upgrade of wastewater treatment plants in the area are among the solutions that potentially may have resulted to positive effects.

According to graphs provided by ALControl Laboratories, 2006, the situation with nutrients pollution in river is much better today than it was back in 80's. Specifically, due to already mentioned measures the nitrogen amount in the water dropped from 1000 ton/year to 800 ton/year for the period of 1985-2006; and the phosphorous content in the water decreased from 23 ton/year to 14 ton/year for the same period of time (ALControl Laboratories, 2006). Although the results are certainly encouraging, they are not sufficient enough.

As in case of river Vege river, the catchment area of which is dominated by agricultural lands, the preliminary classification works implemented for EU WFD showed that the water status is poor or insufficient in the most parts of Vege river mainly because of nutrients load (Lidèn R., et al, 2007). Here, it is also noticeable that the impact on water quality here originates from agricultural, industrial and water treatment sources which are actively ongoing in the catchment area. Specifically, Figure 4 shows, agricultural discharges of nutrients calculated for - N is 87% and P is 64% in Vege river.

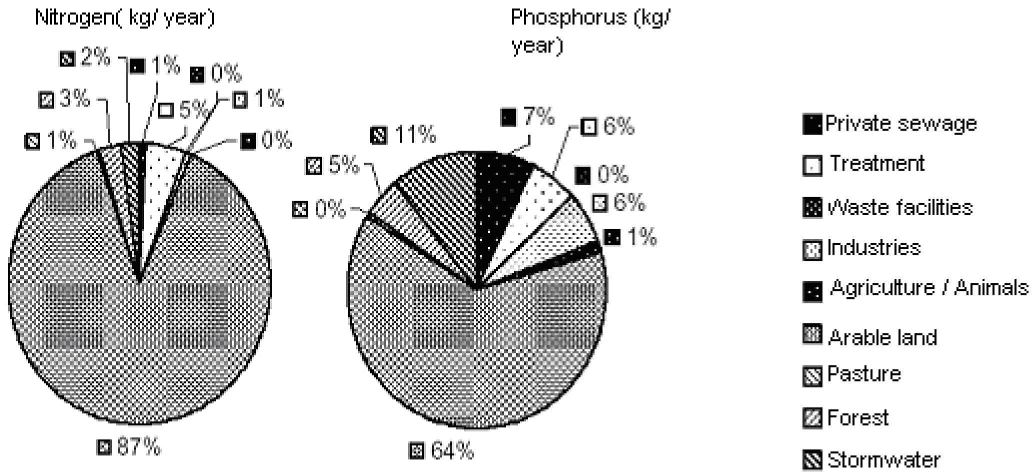

Figure 8 Nitrogen and phosphorous discharges in water
Source: Förlin L., 2007.

In Vege river watershed area it has been established 60 ha of wetlands with EU financial support. However, only about 13 ha of wetlands perform actual cleaning functions. The rest of it is for biological preservation needs, (Förlin L. 2007) and reduced nutrients outflow to Skäldeverken by approximately 1-2% per year (Liden R., et al, 2007). The wetland cleaning efficiency is not very high but it is just another step to cut the nutrient level in the river and reach some ecological balance by time. Nevertheless, to reach the “good status” of water quality suggested by EU WFD, nutrient load needs to cut down by 70-90% (Lidèn R., et al, 2007). Even though wetlands are known to have positive effect on water quality improvement, their cleaning paces are not that effective to catch up with WFD deadlines.

It is interesting to note, however, that wetland option is highly endorsed by EU WFD and EQOs of Sweden adopted by Swedish Parliament. Although this recognition on wetlands’ value, conflicting debates are still on among rural societies whether the specific land locations with high economic/agricultural yield should remain under agricultural use or to be utilized as wetland and river restoration and protection zones. To make the best possible decision it is important to know the value of assets for society and what is being exchanged against what to make tradeoffs. In this concern, the role of economic assessment and valuation studies for water resources becomes more and more actual in decision-making in Sweden.

3.1.3 The three wetland alternatives

This subchapter describing three wetlands alternatives is based on the technical investigation of wetland potentials on Humle tributary of Vege river (Persson O., 2007). Presented maps are from the same source and are developed through GIS software ArcView. The major question answered by this technical study was how effective the cleaning capacity of a wetland can be.

Table 2 Results of the topographic study for three wetland alternatives

	Alternative 1	Alternative 2	Alternative 3
Altitude [m from sea level]	1.5	3.5	3.75
Upstream effects [m]	500	2300	2350
Excavation [m^3]	225000	50000	75000
Retention time [day]	2	2	3
Depth [m]	1.6	1.3	1.5
Area [ha]	6	7-8	9-10
Total converted area into wetland area[ha] [a]	11	14,5	18
Cleaning efficiency - Nitrogen [kg/ha/year]	340	315	310
Cleaning efficiency - Nitrogen [kg/year]	2000	2400	2900

Source: Persson O., 2007

[a] Although the converted area has not been estimated for Vege river wetlands, theoretically it is accepted that the wetland area is about 55% of the total converted area on average (Söderqvist T., 2002)

As Map 1 shows, the catchments area of the tributary Humle is one of the most polluted areas in the basin. Moreover, the technical study on wetland creation on the tributary Humle suggests that the area interfering with the main stream – Vege river, will grasp and reduce the biggest portion of nitrates being transported downstream. This, however, does not suggest locating the wetland on the main stream as it will mean either to dam the main stream or excavate a huge mass of land. As a matter of fact, the excavation work generally considered to be the most expensive part of a wetland construction and the damming of the main stream to be costly and difficult to get the state permission for the activity.

For Vege river to get back to its ecological balance greatly impacted by agriculture, it is necessary to construct a new nutrient reduction sink. This solution is supposed to be an alternative solution to improve the water quality at this stage. The target location is considered tributary Humle, the lying area between the delta of Vege river (Map 2).

The study also reveals that the wetland creation on tributary Humle will directly impact agricultural lands by the expansion of a wetland area and indirectly cause some upstream effects. However, to find out the optimal design for the wetland considering its cleaning capacity and relevant expenses, three different wetland alternatives were suggested. To create any of them on tributary Humle, which is a canalized and dredged watercourse, a dam is going to be constructed to increase the water level.

Wetland Alternative 1

The first wetland alternative (See Map 5) considered to be located in the altitude of +1,5m above the sea level. It is designed to have a minor damming installation on its structure. However, to fill up and reach the required level of water volume for a wetland some extra excavation as massive as 225,000 m^3 will be necessary. To transform a land territory to a wetland area it is necessary the water to get spread out on the landscape.

Technically, it is essential to increase the water level to the surface point by a dam construction as short as 0,4m, for the first alternative. Raised to some point the water will spill out on the landscape and arrange a pool. The arranged wetland will have 6 ha water surface and 11 ha of total wetland area on the converted area. The considered depth of the wetland is estimated to be 1,6m. Water retention time is assumed to be 2 days, as the average water retention time in wetlands is suggested 2 days/year by Tonderski, et al, 2002. Although this wetland existence will cause upstream effects for 500m, it will effectively reduce 340kg-N/ha/year. The map pictures the expected shape of the wetland as a first choice.

Figure 9 Illustration of Alternative 1 by ArcView. *Source: Persson O., 2007*

Wetland Alternative 2

For the second alternative (See Map 6), the wetland altitude is 3,5m above the sea level. To fill up a wetland pool of 7-8ha with the corresponding depth of 1,3m, 50 000m^3 excavation will be needed. Thereafter, 2 days of water retention time is going to be necessary. This wetland will be able to reduce and retain 315 kg-N/ha/year, which is relatively small number compared with the first alternative. Thereafter, this wetland will have huge upstream effect of 2300m as it is a shallow wetland compared to the first one.
It is observable from the Table 3, the soil mass to be excavated is 50 000m^3 meaning that the bigger dam installation will be necessary. However, the soil mass to be excavated is definitely lesser than it is for the first alternative – 225 000m^3. This is an evident of an important cost indication. It is because that the excavation work is known a technical measure producing high expenses for a wetland construction. However, to

avoid massive excavations it is possible to utilize the topography and create a wetland by damming (Söderqvist, 2002).

Figure 10 Illustrations **of the Alternative 2 by ArcView.** *Source: Persson O., 2007*

Wetland Alternative 3

The third alternative (See Map7) is located 3,75m above the sea level. It suggests that to fill up a wetland pool of 9-10 ha with the depth of 1,5m, some 75 000m^3 soil mass needs to be excavated. Water retention time in this pool is calculated to be 3 days with cleaning capacity of 310kg/ha/year. The area and depth units are much greater than they are for the second one, however the cleaning capacity is not as improved as it was for the first wetland.

Figure 11 Illustration of the Alternative 3 by ArcView. *Source: Persson O., 2007*

As one can observe there is a specific relationship among wetland's cleaning efficiency, area and depth parameters. If to increase area and depth units, the cleaning efficiency parameter drops down, and oppositely. With bigger area and depth units, the cleaning efficiency of a wetland is certainly getting higher. However, massive excavation and bigger dam construction works require high expenses.

3.2 *Cost Benefit Analysis of the Vege river wetlands*

3.2.1 Key steps for Cost Benefit Analysis

In practice, CBA stages are (Pearce, et al, 2006):

1. What project is being evaluated?
2. Determining of whose cost and benefits are to be counted - "standing point" principle;
3. Determining a time preferences for society
4. The preferences to know a "relative price" change of the costs or benefits over time;
5. The consideration of the outcomes and uncertainty when no probabilities are known;
6. Identifying the distribution of costs and benefits.

Table 3 summarizes all physical features of those three alternatives that are playing important roles for the Vege river project.

Table 3 Major physical features concerning to Vegeriver wetland CBA study

	Alternative 1	Alternative 2	Alternative 3
Altitude [m from sea level]	1.5	3.5	3.75
Upstream effects [m]	500	2 300	2 350
Excavation [m^3]	225 000	50 000	75 000
Retention time [day]	2	2	3
Depth [m]	1.6	1.3	1.5
Area [ha]	6	7-8	9-10
Total converted area into wetland area[ha] [a]	11	14,5	18
Cleaning efficiency - Nitrogen [kg/ha/year]	340	315	310
Cleaning efficiency - Nitrogen [kg/year]	2000	2400	2900
Trapping efficiency for phosphorus and other sediments [%]	40	40	60
Biodiversity total: [c]	81	83	84
- aquatic flora	30	30	30
- aquatic fauna	36	36	36
- birds	15	17	18

Source: Adjusted from Table 2 (Persson O., 2007)

3.2.2 Major cost components

In this subchapter the cost components will be discussed.

The construction cost

In the Table 3, the construction work is presented by three parameters: excavation, soil transportation and damming. These costs represent the actual and practical work at the wetland site to convert the area to a wetland area and give the area that special shape of N reducing pool. Specifically, excavation works usually cost 30SEK/m^3 and can be doubled if the soil mass needs to be transported out of the territory (INTERREG IIA, 2005). For calculation purposes another 30SEK/m^3 is used for the transportation in this study. However, it is thought that not all of the excavated soil needs to be transported as some of it will be used to secure/fasten banks and design side slopes. It is assumed that only 50% of the excavated soil mass will be transported out from the territory and the second half of it will be used as on-site construction material.

Expenses for dam construction are based on Helsingborg's municipality calculations for Rå river located wetlands. Here, 15 000 SEK/ha for wetland is used as a basic calculation. For wetlands being discussed in this study, the area element is only the pool area, and not the converted area.

Administrative/consultancy cost

Administrative and consultancy jobs are valued as 70 000 SEK/wetland as a model cost, according to Söderqvist T, 2002.

Land Compensation

The interest rate development for 1997 and 2006 were 113% in 1997 and 153% in 2006, (Sveriges Officiella Statistik, JO 38 SM 0501 o 0701). Given to this, the land compensation for 1997 and 2006 were estimated to be:

3750 UDS x 7,5 = 28.000 SEK/ha in 1997,
3750 UDS x 7,5 x 1,35 %= 38.000 SEK/ha in 2006 price level.

where 7,5 SEK =1 USD in 1997 (Söderqvist T, 2002)
1,35% - Change in consumer price index (1997 -2006)
3750 USD /ha – the average land compensation for Kävlinge river project in 1997 (Söderqvist T, ENVECO - Environmental Economics Consultancy, Personal Communication).

In comparison, Sveriges Officiella Statistik states that the average price on land in Southern Sweden was 28.500SEK/ha in 1997, and 70.300SEK/ha in 2006 respectively. Certainly, these numbers may differ because of the soil quality classification (0-10 scale) on various regions are different and figures are presented through average numbers.

The Maintenance Cost

The maintenance cost is calculated to be around 2500 SEK/year based on a study that Ekologgruppen has provided for Höje river project. They estimated the maintenance cost of each constructed wetland to be about USD 250/year

Table 4 Major cost estimations for wetland alternatives presented by per unit cost

Cost measures	***Alternative 1***		***Alternative 2***		***Alternative 3***	
	Quantity	***Cost per unit SEK***	***Quantity***	***Cost SEK***	***Quantity***	***Cost SEK***
Construction cost						
- Excavation [SEK/m^3][a]	225 000	30	50 000	30	75 000	30
- Soil transportation by tracks [SEK/m^3][b]	112 500	30	25 000	30	37 500	30
- Damming [SEK/ha][f]	6	15 000	8	15000	10	15 000
Administrative/consultancy cost [SEK/wetland][c]	1	70 000	1	70 000	1	70 000
Land lease compensation [SEK/ha][d]	11	40 000	14,5	40 000	17,5	40 000
Maintenance cost [SEK/wetland/year][e]	1	2 000	1	2 000	1	2 000

[a, b] Source: INTERREG IIA, 2005 ; [c, e] Source: Söderqvist T, 2002;[d] Source: Ekologgrupen, 2004;
[f] Quantity figures apply for wetland surface only, not with the converted area part. Source: Persson P., et al, 2005.

3.2.3 Major benefits

3.2.3.1 Benefit transfer method

As to estimate the economic values of wetlands through CBA it is possible to apply Benefit Transfer method to transfer the existing benefit estimates from one relevant study to another. Usually, this method is used when it is too expensive to afford or there is not much time available to conduct the site specific survey. Thereafter, the benefit transfer method is applied to estimate the economic value of ecosystems and their services, such as wetlands.

For this study, it is done by transferring the available information from studies that have been already conducted for other locations and contexts in southern Sweden, which are regarded as relevant to the Vege river study. However, it is essential to mention that the benefit transfer method can be as accurate as the initial study (Ecosystem Valuation, n.d.). For example, to estimate values for wetlands to be built on Vege river watershed area it is possible to transfer wetland values from one study to other wetland valuation studies relevant with their specifics (e.g. location, area, size, population number, etc).
Steps that are used to apply benefit transfer method are followings (Ecosystem Valuation homepage):

1. Identification of the existing studies or values can be transferred to others. In the case of the benefit transfer for Vege river wetland CBA study, it is necessary to find another CBA or relevant study valuing the benefits of wetlands and their services as nitrogen sinking pools.
2. Finding whether the values are transferable based on following criteria:
   - If the services of Humle tributary wetlands are comparable to the services (types, quality and substitute sites) that are valued in the existing study,
   - If the demographic characteristics are similar between the studies.
3. The evaluation of the quality of the existing study to be transferred, as the better is the quality of it, and then more accurate will be the transferred values of the ongoing study.
4. The adjustment of the existing values, as the final step, to better reproduce the values for Humle tributary wetlands, using as much information as on hand.

3.2.3.2Major benefit components anticipated and relevant estimations

In identifying wetland functions it is convenient to assess a particular wetland by functions it is likely to perform (US Army Corps of Engineers, 1995) and not by all other functions that other wetlands might perform to the same degree or magnitude.

Above mentioned argument implies to an important point in consideration of benefits and their transfer during the sensitivity analysis to assign values to a specific wetland with a limited level of functionality (See more in 4.5). All three wetland alternatives that are proposed to be established on Humle tributary, possess benefits and values of wetlands with similar functions. The nitrogen trapping feature is the primary advantage of wetlands in the nature and the particular reason for their planning on Humle tributary.

At the initial period of their establishment wetlands anticipated to perform as nitrogen removal/cycling, nutrient and biogeochemical cycling reservoirs and function as ecosystem integrity units for the ecosystem in longer perspective. As to remind, the wetland life time is assumed to be 50 years which is enough for a wetland to reach its ecosystem integrity phase. In Table 6 it is possible to observe the major benefits that are expected from wetland alternatives on Humle tributary.

3.2.3.3 Monetarised benefits values

The framework of the social CBA implies that all cost and benefit values should be monetarised (expressed in financial terms, SEK/ha) in order to be introduced into the net present value calculation. Monitarisation of environmental benefits and finding the environmental cost is possible to do in the extent possible applying data from existing studies and using relevant financial valuation methods done previously.

Reduced Nitrogen

The monetarised environmental cost for the reduced nitrogen in wetlands is specified as 25 SEK/kg-N. The cost information is transferred from Kävlinge river project implemented in 2004 (Ekologgrupen, 2004) and illustrated how much it will cost to reduce nitrogen to the society. According to this, the nitrogen reduction cost results are 25 SEK/kg-N (5 %

interest, 30 year of time frame) which is similar to Vege river study (4% interest, 50 year of time frame). Similar calculations are shown by Höje river project calculating nitrogen reduction cost as 31 SEK/kg-N (6% interest rate, 30 year of time frame) (Ekologgrupen, 2004). Alternatively, in Söderqvist, 1999, nitrogen reduction cost estimations are 14-22 SEK/kg-N in wetlands (5-7% interest rate, 30-50 year time frame), which is quite similar to wetland project on Vege river too. As results from Naturvårdverket depict nitrogen reduction cost through wetlands can cost 37 SEK/kg-N/year (Naturvårdsverket, 2007).

Reduced Phosphorous

There is a linear relationship between the area specifics and cleaning capacity of a wetland. However, as higher the P concentration in the inflowing water that considerable will be P reduction in the wetland (Tonderski K., et al, 2002, p 77). As the same source reveals, wetlands will be able to catch about 1,5 g-P/m^2/year within mineral soil and 0,3g-P/m^2/year in organic soils.[1]

However, by area specific approach, results can be dissimilar. In the Table 5 results of the P-reduction survey conducted in Sweden, Norway and Finland it is observable capacities of shallow wetlands and dams to reduce P.

Table 5 P-reduction in shallow wetlands and dams in agricultural lands in Sweden, Norway and Finland

	Area specific P reduction (g/m^2/year)	Relative P-reduction (%)
Shallow wetlands	31- 116	30-50
Dams	2-46	7-20

Source: Tonderski K., et al, 2002

According to Naturvårdverket, the phosphorus emission from agricultural lands to the water is 0,4kg/ha/year and costs 1125 SEK/kg-P to reduce per unit of Phosphorous in water (Naturvårdsverket, 2007). For each of wetland alternatives that will be 2,4kg/year, 3kg/year and 4kg/year respectively to 6ha, 7,5ha and 9,5ha wetland areas. Benefit estimations are given in the Table 6.

Trapping efficiency

Trapping efficiency for phosphorous and other sediments has been estimated by Brune and Brown methods and showed roughly same results (See Appendix 8.2). It might be interesting to note that wetlands as nitrogen trapping pools do not have the same trapping efficiency. It highly depends on the volumes of the inflow and volume of reservoirs, as well as the amount of nitrogen load into them (as higher the better). The efficiency of nutrient reduction also depends on soil composition, pH level in the soil, reservoir design and land cover in the area.

[1] Mineral soils are classified according to their grain sizes and distribution in the soil structure. Organic are soils comprises more than 20% of organic material. (Swedish Geotechnical Institute, 2008)

Biodiversity number

The next step is to quantify and indicate the biodiversity number that will reside to Humble wetland area. Biodiversity types and numbers are derived from the Kävlinge river project conducted by Ekologgruppen in south-western Sweden. Thereafter, biodiversity figures can be roughly generalized and transferred to the Humle tributary wetland study and make a general assumption on biodiversity numbers (Nysröm P., 2008, January 30, Personal Interview). Even though it is observable that Kävlinge river catchment area is much bigger than it is for Vege river(492km^2) it is still possible to transfer biodiversity numbers from one case to other. The area has similar specifics such as climate, geography, population numbers and biodiversity types that appear in the areas. The key issue for species that will reside the area through migration from one site to other is certainly the quality of the environment, but not the area factor of the wetland.

Afterwards, to indicate the number of biodiversity communities in Humle tributary as an environmental benefit value from the wetland function, a similar project need to be chosen to derive with Willingness to Pay (WTP) figures. A choice experiment survey conducted to estimate peoples WTP for wetland attributes for the municipality of Stafanstorp (Carlsson F, et al, 2002) is going to be a supply source for Vege river study. The choice experiment was applied for a wetland area situated in Staffanstorp to discover which wetland functions are important to the community members such as "high biodiversity" or "medium biodiversity" as a sign of a density. Thereafter, the study tried to estimate WTP of respondents for above mentioned functions. Respondents represent local community living in the municipality area. The questionnaire was sent to 130 randomly chosen individuals that got fact-sheet on wetland attribute descriptions and then answered to four choice sets. The biodiversity number indication part for Humle tributary is based on the results of this experiment.

In the same source, "fish" attribute is given as separate characteristics to a wetland. Vege river study applied "aquatic fauna" term which captures all aquatic population types that will come up in the wetland sooner or later. However, with the consideration that wetlands are not planned to serve as fish-ponds, the focus is mainly on the other aquatic species, such as amphibians and others, but not fish.

3.2.3.4 Non-monetarised benefit values

Non-monetarised benefits may not implacable to calculations for benefit values, however they do provide with significant insights and indications on the relevant value. A wide range of the benefits was not possible to monetairse due to the lack of methods and importantly lack of available and existing data.

Recreational interests and competition

Generally, it is supposed that wetlands certainly carry interest for the recreational opportunities for people who enjoy being out in the nature. However as the interview process undergoes it appeared that the recreational interests that a wetland represents have a linear dependency on the conveniences and commodities that wetland site could offer, according to Frilufsfrämjandet. Attributes such as easy accessibility to the area in form of paths, roads or bridges, or bird-watching towers, parking spots, break conveniences, WC facilities, etc. apparently have quite strong influence on peoples' choice on recreational places.

Another important factor that affects on the choice of recreation sites is the transport communication infrastructure. If to look at the area map to find out communication possibilities it is observable that the wetland spot is not far from major motorways E6 and E20, as well as from the railroad. These factors make the wetland area conveniently attractive and competitive to other recreational sites in Vege catchments area. For example, national park Söderåsen located near to Kageröd, is a popular and established recreational spot in Skania. There is also couple of recreational sites near to Vegeholm and at the point where Vege river opens to the sea - Skäldervik area known for their beautiful nature, landscape and scenery.

Reduced erosion

The wetland will have some balancing effect on high flows by delaying runoffs and possibly having some limited control over the erosion. However, any of the planned wetland alternatives is not sizeable enough to be able to lower high flow picks during seasonal runoffs, unless a groundwater recharge happens here.

Flood control

Sizes of planned wetland alternatives are ranging from 6-10 ha. These figures indicate that wetlands are not big pools and are not covering large areas. Consequently, as wetlands of those sizes they will not be able to control any flood event in the area even at the small runoff peaks (Lidén R., personal communication). However, wetlands will have upstream effects and might support the flooding occurrences there. That is why flood control has a "-" sign in the table.

Groundwater in- and outflow

Generally, groundwater in- and outflows from the wetland occurs all the time. But will that affect to society's welfare in anyway? Normally, the groundwater inflow (discharge) into the wetland simply changes the water quality and temperature similar to its own. Consequently, this will affect to the ecology and biodiversity types in and around the wetland either positively or negatively (Hans Jeppsson, Sweco Viak, Personal Communication).
Another factor is the role of the groundwater to contribute flooding events. According to Persson, 2007 the soil type in the area is characterized as clay-silt material. This means that the bed material of the wetland is going to be mostly impermeable for water infiltration through surface soils. Although some very small interaction between the groundwater and wetland water will be possible, the process is known as very slow to control any flooding events here (Hans Jeppsson, Sweco Viak, Personal Communication). It is because that the quantity of the inflowing water from upstream Humle tributary is much more massive than it is actually possible to handle and control it through the groundwater recharge. Given to this, the contribution of groundwater to the flooding events is identified as non-beneficial for the society's welfare

Better land allocation

The area where the wetlands are planned to be constructed (See Map 2) is partly a grazing area and being used for agricultural purposes only to some extent. Although the argument that using this area for the wetland constructing is more preferable as it has less value for the society and agriculture, it is might carry a potential conflict of interests on land allocation issue.

Better landscape aesthetics

To enhance a better landscape aesthetics it is favorable to include a water mirror "sparkling" on the landscape for viewers' enjoyment. It will not only encourage flora and fauna types to enrich the biodiversity in the area but also add visitors' welfare just by looking at the nature scene.

Irrigation possibilities

The climate in southern Sweden is mild cold with cloudy winters and summers (About.com, 2008). Here, it is rare that irrigation measures seen as a common practice for agricultural activities. It is more often that farmers will rely on weather events and intense precipitation to irrigate lands. So, it is the benefits out of irrigation possibilities seen as insignificant for the welfare of the society.

Sport hunting/fishing interests

The presence of a wetland in the area will encourage and sustain various biodiversity types in the area. Fish, bird and terrestrial species are expected to reside the wetland area as soon as the wetland will be constructed. This factor makes the wetland an attractive spot for sport hunting/fishing activities. Today there are several places on Vege river for sport fishing/hunting activities and actively functioning. Thus, it is supposed that the wetland can represent interest for this attribute not only for common citizens but also for related authorities, such as Fisherman Association (Fiskeföreningar) or Promoting Outdoor Recreation NGO (Frilufsfrämjandet).

Scientific interest

In the area there are several universities and institutions that work within fields such as biology, ecology, agronomy, water resources engineering, landscape architecture, etc that might be interested at a nearby located wetland as a study station. As one source reveals at least one person per month will be engaged in measurement surveys (Per Nyström, Limnology Dep., LU, Personal Communication). As another source reveals this wetland represent potential interest for study groups interested in water related issues. As a very rough estimation, study groups usually comprise of 50 people and they may visit the wetland site 4 times/year. This significantly adds value to the wetland existence in the area (Rolf Larsson, Vattenresurslära, LTH; Personal Communication).

Methane gas production

Wetlands can also have effect on the methane gas production (Naturvårdsverket, 2007). That effect is negative and supporting to the increase of methane gas level in the atmosphere.

Table 6 Monetarised and non-monetarised values from Vege wetlands

	Alternative 1		Alternative 2		Alternative 3	
Benefit measures	***Quantity /per year***	***Cost SEK/per unit***	***Quantity***	***Cost SEK/per unit***	***Quantity***	***Cost SEK/per unit***
Monetarised benefit values						
Reduced Nitrogen [kg/year]	2000	37[a]	2400	37	2900	37
Reduced Phosphorous [kg/year]	2,4	1125[b]	3	1125	4	1125
Non-Monetarised benefit values						
Recreational interest [g]		+++		+++		+++
Trapping efficiency for phosphorus and other sediments [%]		+++		+++		+++
Biodiversity numbers [c]		+++		+++		+++
Better hunting/fishing possibilities		+		+		+
Scientific study interest (per visit)[k]		++		++		++
Reduced erosion		+		+		+
Groundwater in and outflow [d]		±		±		±
Better landscape aesthetics		+++		+++		+++
Better land allocation		+		+		+
Irrigation opportunities		±		±		±
New income interest [e]		++		++		++
Flood control [f]		-		-		-
Methane gas production [h]		-		-		-

[a, b, h] Source: Naturvårdsverket, 2007 . The cost for P reduction is estimated based on studies Scharin, 2005; Gren, et al 1997, Elofsson, 1999, according to Naturvårdsverket, 2007
[c] Source: Life, 2000
[d] Source: Personal communication, Hans Jeppsson, Sweco Viak AB, 2008
[e] Source: Personal communication, Tommy Johnsson, Naturskydd---, 2008
[f] Source: Personal communication, Rikard Liden, Sweco Viak AB, 2007
[g] See more in Sensitivity Analysis part. Source: Personal communication, O. Persson, Sweco AB, 2008
[k] Source: Personal communication, Per Nyström, Limnology department, LU and Rolf Larsson, Vattenresurslära, LTH

* The sign "+" stands for a positive benefit (+++ is the most), the sign "-" is a negative effect, "±" is a benefit that leads either to conflicting interests or to insignificant effects for the society.

3.2.4 Costs and benefits of Vege river wetland

In the result of cost and benefits relationship the table was made to depict cost and benefit data at their annual and Net Present Value (NPV) costs (See Table 7). Furthermore, time frame and discount rate are considered (See more at 1.4.1 and 1.4.2.). The relationship suggests that the wetland development on Vege river is not economically reasonable as the Net Benefit value possess negative figures.

Table 7 Initial and Annual cost changes in 50 year time perspective

Time frame and discount rate	**50 years, 4% discount rate**					
Alternatives	**Alternative 1**		**Alternative 2**		**Alternative 3**	
Current costs and discount rates over 50 years	**Annual costs SEK**	**NPV SEK**	**Annual costs SEK**	**NPV SEK**	**Annual costs SEK**	**NPV SEK**
Costs						
Construction cost		10 215 000		2 370 000		3 525 000
Administrative/consultancy cost		70 000		70 000		70 000
Land lease compensation		440 000		580 000		700 000
Maintenance cost [SEK/year]	2 000	42 000	2 000	42 000	2 000	42 000
Total cost		**10 700 000**		**3 000 000**		**4 300 000**
Benefits						
Nitrogen reduction cost	75 000	1 600 000	90 000	1 930 000	100 000	2 300 000
Phosphorous reduction cost	2 700	60 000	3 500	70 000	4 500	100 000
Total benefits		**1 660 000**		**2 000 000**		**2 400 000**
Net Benefit =Benefit-Cost		**(9 000 000)**		**(1 000 000)**		**(1 900 000)**
Recreational interest [g]		+++		+++		+++
Trapping efficiency for phosphorous and other sediments [%]		+++		+++		+++
Biodiversity numbers [c]		+++		+++		+++
Scientific study interest (per visit)[k]		++		++		++
Better landscape aesthetics		+++		+++		+++
New income interest [e]		++		++		++

3.2.5 Sensitivity analysis

To make an accurate benefit transfer there are two important points to be considered:

- Similar functions of wetlands; and
- Comparable population number at the municipalities

The two wetlands with comparable sizes and functions are selected at the municipalities with comparable population number. These data are applied to transfer the benefits of the similar wetlands located at the Staffanstorp and Oxelosund municipalities to Vege river wetlands situated at the Ängelholm municipality in Sweden. Knowing the average WTP for wetlands located at Staffanstorp and Oxelosund municipalities it is possible to estimate the average WTP for Vege river (See Table 8).

Table 8 Data of selected municipalities with comparable sizes and wetlands services applied to estimate Average WTP for third municipality

Municipality	Staffanstorp	Oxelösund	Ängelholm
Population number per municipality	21 000	15 000	35 000
Wetland area (ha)	15	23	15
Average WTP	400	270	**300**

Source: Söderqvist T, 2002; Andersson. J, et al, 2000

As it is observable that the three wetland areas of similar sizes 15, 23 and 15 ha are located at the municipalities of relatively comparable population numbers 21 000, 15 000 and 35 000. It was known that WTP for Staffanstorp wetlands as a recreational site is 400 SEK/person (Söderqvist T, 2002). WTP for Oxelösund wetland as another recreational area is 270 in average (170-370 SEK/person) (Andersson. J, et al., 2000). Assuming that there is a linear relationship among the population number, wetland area and Average WTP functions, the average WTP for the Ängelholm community is estimated 300SEK/person. As the highest WTP value is 400 SEK/person and the lowest costs 270 SEK/person the average value is assumingly estimated to be 300 SEK/person for Vege river wetland area (see Table 9).

Table 9 Assumed WTP of per person for the recreational value of Vege river wetland

WTP in SEK/person for Vegeriver wetland	**300**		
Time frame	**50 years**		
Alternatives	**Any alternative**		
Number of visitors per year*	**No Change in recreational value over time**	**Increase in recreational value by 1%/ year**	**Increase in recreational value by 2%/ year**
300	2 100 000	2 550 000	3 110 000
500	3 500 000	4 250 000	5 200 000

* *According to interview results the expected visitors for recreation would be roughly 300-500 visitors/ year (Naturskyddsforeningen, 2007)*

In accordance of the provided information that 300-500 visitor/year would be willing to drop by Humle tributarys wetland, then the recreational value ranges SEK 2.1 – 5.2 millions.

Moving forward it is observable from the Table 10 that expected total benefits from the wetland in 50 years at the 4% discount rate will amount to SEK 1 700 000 – 2 400 000 against the total cost of SEK 3 000 000 – 10 700 000. Net benefits for each case reveal that it is unreasonable to construct the wetland by current values. However as the sensitivity analysis reveals if to consider WTP for recreational benefit then the situation may dramatically change.

As we can see Alternative 1 is still economically not reasonable to construct. Alternative 2 shows Net benefit value to have positive sign. As it is it is beneficial to start with wetland project Alternative 2 with expected benefits of SEK 1.1-4.2 millions. In fact this option is the most favorable one, according to results obtained by sensitivity analysis. Alternative 3 is less beneficial than the 2nd one but it is still economically agreed providing SEK 0.2-3.3 million benefits if the assumption on recreational WTP is in force.

Table 10 Cost benefit relationship with the recreational value consideration

Time frame	**50 years, 4% discount rate**					
Alternatives	**Alternative 1**		**Alternative 2**		**Alternative 3**	
Current costs and discount rates over 50 years	**Annual costs in SEK**	**NPV in SEK**	**Annual costs in SEK**	**NPV in SEK**	**Annual costs in SEK**	**NPV in SEK**
Total cost		10 700 000		3 000 000		4 300 000
Total benefits		1 660 000		2 000 000		2 400 000
Recreational interest		*(2 100 000- 5 200 000)*		*(2 100 000- 5 200 000)*		*(2 100 000- 5 200 000)*
Net Benefit =Benefit-Cost		**[(7 000 000) – (4 000 000)]**		**[1 100 000 – 4 200 000]**		**[200 000 – 3 300 000]**
Trapping efficiency for phosphorus and other sediments [%]		+++		+++		+++
Biodiversity numbers [c]		+++		+++		+++
Scientific study interest (per visit)[k]		++		++		++
Better landscape aesthetics		+++		+++		+++
New income interest [e]		++		++		++

2 Alternative 1: 10 700 000SEK / (2000kg x50years) = 107 SEK
Alternative 2: 3 000 000SEK / (2400kg x50years) = 25 SEK
Alternative 3: 4 300 000SEK / (2900kg x50years) = 30 SEK

Oppositely if no recreational values were considered, then it would be interesting to discuss the socio-economic profitability of Vege wetland through the comparison between average wetland with the marginal N-reduction cost 37 SEK/kg-N (Naturvårdverket, 2007) and the Vege wetland N-reduction cost of for three alternatives in 50 years (without discount rate) 107SEK/kg-N, 25 SEK/kg-N and 30 SEK/kg-N respective to Alternative 1, Alternative 2 and Alternative 3.

It is observable that Alternative 1 at the 107 SEK/kg-N is still not profitable if to compare with 37 SEK/kg-N estimated by Naturvårdverket. But the picture is quite different for Alternative 2 at the N reduction cost 25 SEK/kg-N and Alternative 3 at the cost 30 SEK/kg-N. So, if no discount will take place on the value over 50 years then Alternativ 2 and Alternative 3 are becoming cheaper than the marginal abatement cost for N calculated by Naturvårdverket. In contrary, it is beneficial to observe the cheaper and relatively effective N and P abatement measures (besides wetlands) that are considered by Naturvårdverket. In Table 11, various N and P measures are considered.

Table 11 The comparison of N and P abatement measures based on their economic efficiency (Marginal Abatement Cost (MAC)) and abatement effectiveness (reduction in tons)

Measures	MAC SEK/kg	Potential Ton
N Abatement		
Mussel cultivation	36	450
Draining	80-240	300
Catch-crop cultivation	99 -350	500
Total average	400	1250
WETLANDS	*37*	*1300*
P abatement		
Mussel cultivation	350	35
Damming	948	10
Complement individual sewage systems	7700-9640	21-24
Total average	9800	65
WETLANDS	*1125*	*4,5*

Developed based on the source: Naturvårdsverket 2007

By relying on measures or the group of measures (other than wetland) such as mussel cultivation, draining and catch crop cultivation for N and P abatement it is necessary to consider the investment of at least 400 SEK/kg-N to attain 1250 ton-N abatement, and 9800 SEK/kg-P to attain 65 ton-P.

It is notable that MAC measures other than wetland are much higher for community if they decide to apply the group of measures to replace the natural functions of wetlands. They can cost up to 400 SEK/kg-N and 9800 SEK/kg-P.

MAC of a wetland is as low as 37 SEK/kg-N and 1125 SEK/kg-P according to calculations. This means that the wetland measure is still dominating as the most effective measure by its cost and abatement efficiency for N and relatively for P and the economic benefits related to wetland's environmental functions are still considerable. And, if for example, a community decides to use all other measures for N abatement to replace natural functions provided by wetlands, the costs could far outweigh the land, crop and mussel purchase price of preserving the natural wetland systems.

To find out the total saving for the society to apply a wetland measure for Vege river, it is necessary to consider the discount factor 4% over 50 years for wetlands in calculations. The indicative savings for the society in case of Vege wetland construction will range MSEK 17,5-26 per year (Table 12).

Table 12 Total savings of the Vege wetland alternatives expressed in million SEK

	N abatement at Vege wetland million SEK	P abatement at Vege wetland SEK	**Total savings SEK**
Alternative 1	17[3]	0,52[4]	**17,5**
Alternative 2	21	0,61	**22**
Alternative 3	25	0,87	**26**

[3] Alternative 1: (400/37)x 1 600 000= SEK 17mil
Alternative 2: (400/37)x 1 930 000= SEK 21mil
Alternative 3: (400/37)x 2 300 000= SEK 25 mil
[4] Alternative 1: (9800/1125) x 60 000= SEK 0,52mil
Alternative 2: (9800/1125) x 70 000= SEK 0,61mil
Alternative 3: (9800/1125) x 100 000= SEK 0,87mil

4 Discussion

4.1 Conflict of Interests

Values of dams and wetlands for the environment and biodiversity in agricultural areas are well known and documented. Despite major changes in agricultural landscapes to drain wetlands and lower the water level to create more agriculture areas in Southern Sweden, cultural attitudes of people toward wetlands as natural assets is mostly changed today. This can be seen as a direct result of national environmental objectives accepted by Swedish parliament concerned to wetland resources.

Administrative and institutional conflicts

National actions toward environmental quality objectives of "Zero Euthrophication" has been stated as very difficult to attain within one generation, i.e. 2020 by Swedish EPA (Naturvårdsverket, 2007). It also was proposed by EPA to remove wording of "*The objective is intended to be achieved within one generation*" in EQO text, and develop the common interpretation of the wording of each individual EQOs to be developed as part of the work on the overall report by EQO Council (Naturvårdsverket, 2007: 5768).

Thriving Wetlands is an example of the objective to establish or restore at least 12,000 ha of wetlands and ponds on agricultural lands by 2010 (Environmental Objectives Portal, 2007). A part of this objective is that landowners must be encouraged to create and/or restore wetlands (Regeringskansliet, 2006).

Regional Environmental Objectives of Southern Sweden suggests that 5 000ha wetland areas need to be established in Skane, 2 500ha out of which should be ready by 2010 (Länsstyrelsen 2007:5). Additionally as EU WFD requires, by 2009 administrative and action plans/measures should be accomplished at each RBDs in order of reaching good chemical and ecological statuses for water (Länsstyrelsen 2007:5).

Oppositely, current Swedish Environmental Code states that the agriculture and forestry sectors are representing national interests of Sweden (Swedish Environmental Code (SEC), 1999, Ch. 3, Sec. 4). This means that any action or intended measure carried out toward the environment or natural resources in Sweden need to be prioritized by national interests.

It is true that SEC recognizes the importance of environment and natural resources protection and that it has its current difficulties to cope with EQOs and EU WFD. However, this is not the only obstacle that EQO implementations are facing.

For wetland creation the land allocation issue - from agricultural use to nature conservation projects - causing a definite conflict of interests among stakeholders, such as state and rural community.

Land property conflict

In Skane, the agriculture symbolizes traditional and historical values for rural societies living here. They inherited the culture from their ancestors and would like to pass it to next generations. Also, agricultural lands are representing a property value for its owner. It is certain that the physical size of agricultural lands is simply going to be changed by wetland creation. If decades ago wetlands were drained to open more space for agricultural utilization, today by wetland creation projects agricultural land territories are going to “shrink” back effecting land territories and properties.

Rural communities used to preserve their land areas in the territories where wetland measures could be possible through piping and other construction works without having municipalities’ reaction on this. This especially applies to flat areas where there is an great need to create wetlands (Länsstyrelsen 2007:5).

The probable “lost” of their land properties leads to a bold anxiousness among the rural community about their properties. It is still more common that market-oriented approach takes over environmental concerns in many communities. In most part of the west–eastern Skania the land has high quality standards making market prices for land properties more and more expensive by each year.

It is interesting to mention that on one hand SEC still provides strong backup through the prime interest on agriculture without any significant changes in environmental laws to assist wetlands/damming projects. On the other hand, state does support environmental projects to be implemented on agricultural lands providing compensation alternatives to the farmer and other interested stakeholders offered by EU or Jordbruksverket. This mechanism certainly provides with driving forces to motivate the farmer in assisting the wetland project on their lands based on their own choices. There are several cases that Höje and Kävling river projects have registered initiatives of farmers and interest in wetlands and open water surface projects on their lands whether with compensation payments for their land lease or not. However, market prices on land properties are still “limiting” factors.

Given to this, wetland creation on the agricultural land became a truly difficult issue for the state or private institutions to tackle on with rural communities. It is believed that without any actual upgrades in SEC supporting the implementation of EQOs and wetland creation projects on agricultural lands, environmental goals to be reached within the certain time frame might still be pending.

Time conflict

Another conflictive issue concerning to wetland creations, specifically with the Thriving Wetland objective implementation, is the need of immediate reduction and the slow pace. Council on Environmental Objectives of Sweden (Miljömålsråd) states that the time speed is low for both creating and protecting wetlands and incentives for land owners to create or restore wetlands need to be strengthening up.

As to mention again the regional environmental objective on Thriving Wetlands for Southern Sweden suggests that 5 000ha wetland areas need to be established in Skania, 2 500ha out of which should be ready by 2010, with starting point - year 2000. But as the same source reveals, it is believed that the time frame needs to be doubled in order to fulfil requirements to reach this goal (only for water quality). Meantime, this also applies to the quality of maintained works that needs to show a considerable enhancement by time.

As it is calculated by Länsstyrelsen since 2000 to 2005, May, it is only 786 ha wetlands have been created in Skania. With current implementation speed it is expected to have about 1 500 ha wetlands created by 2010- starting point is the year 2000. (Länsstyrelsen 2007:5)

Biodiversity conflict

It is well known that wetlands are excellent inhabitant for many terrestrial and aquatic species. In this regard, the construction of the wetland will lead to some major changes importantly affecting different ecosystems that provide home and shelter to various species. Changes such as decreased water flow speed, increased water temperature, high evaporation rates during summer and intensified behaviour of predator pikes in the wetland are principally expected.

Because of the wetland creation here and all subsequent changes many species will migrate out from the area in the search of new homes and many others are supposed to reside the wetland area. Species such as fish, frogs, toads and salamanders that prefer the aquatic environment of this specific wetland are mostly expected to inhabit the area. Even some mammal species that depend on drinking water sources and nutrient-rich grazing spots will migrate here. In Skania, there are red and roe deer as well as wild pigs that are common for this area (Jägareförbundet, 2003).

Although it was mentioned before that fish is not a focus for this wetland study, it is most certain that fish is an important part of the food-chain and its arrival factor in wetlands cannot be eliminated from the entire picture. Predator pike will have a controlling role for other fish population appearance in the wetland. The behavior will be especially observable at the point where Humle tributary will flow into the wetland and bring other aquatic organisms with the current flow. Most of them, such as trout and salmon will be eaten on their migratory way to the wetland by pikes. Some fishes such as trout or salmon will definitely appear in the wetland as fish eggs being carried by stream current anyway (Per Nyström, Limnology Dep. LU, Personal Communication).

In the wetlands that create good environment for amphibians fish populations do not dominate in these wetlands. For example fish do not coexist with salamander Triturus cristatus (toxic for fish adu lts), but they do coexist with salamanders Triturus cristatus or toads Bufo bufo in same waters (Per Nyström, Limnology Dep., LU, Personal Communication). In the shallow wetlands the water is warm and rich in macrophytes (aquatic plant). Some types of fish do not like this environment and therefore prefer deeper wetlands. Subsequently, fish source will determine bird species to reside the area. Although the food factor, it is most certain that aspects such as quality of wetland environment (not the area specifics) or competition issues will influence on birds' migration.

Cultural and historical value conflict

There are numerous ancient remains and monuments that are found in Southern Sweden. According to Ekologgruppen 2004, many of them that are close to water bodies and dams/ wetlands can be in conflict with historical and cultural values. Sometimes dam/wetlands projects cannot be conducted in the areas where there are ancient remains, monuments or sacrificing places that has historic values for the country. It is Länsstyrelsen I Skania (county administration board) that decides if the project can or cannot be performed in these areas. In some cases an archaeological investigation/expedition requires to precede construction works. It is interesting to mention that during the implementation of Höje river project, Länsstyrelsen in Skania had refused wetland construction assignments just because the chosen locations were in conflict with the cultural/historical values in the area. In some areas the project paid for various archaeological investigations for about 20.000 - 30.000 SEK.

As it was mentioned before, the chosen location for the wetland construction is on the confluence of Vege river and its tributary Humle. As the map for Registered Ancient Remains (Forminneregister karta) from Länsstyrelsen i Skania reveal the area of outer limit to the wetland does contain three ancient remains. It has been confirmed by Kulturmiljösektionen i Länsstyrelsen that those are stone-aged housing remains carrying cultural and historical values for the society. Mentioned remains are legally protected by the state. Any changes on the landscape that may affect ancient remains require state permission and a possible conduction of an archaeological investigation (Anders Wihlborg, Lännstyrelsen. Personal Communication). Given to this it is supposed that the wetland construction project may be in a conflict with cultural and historical interests of the society.

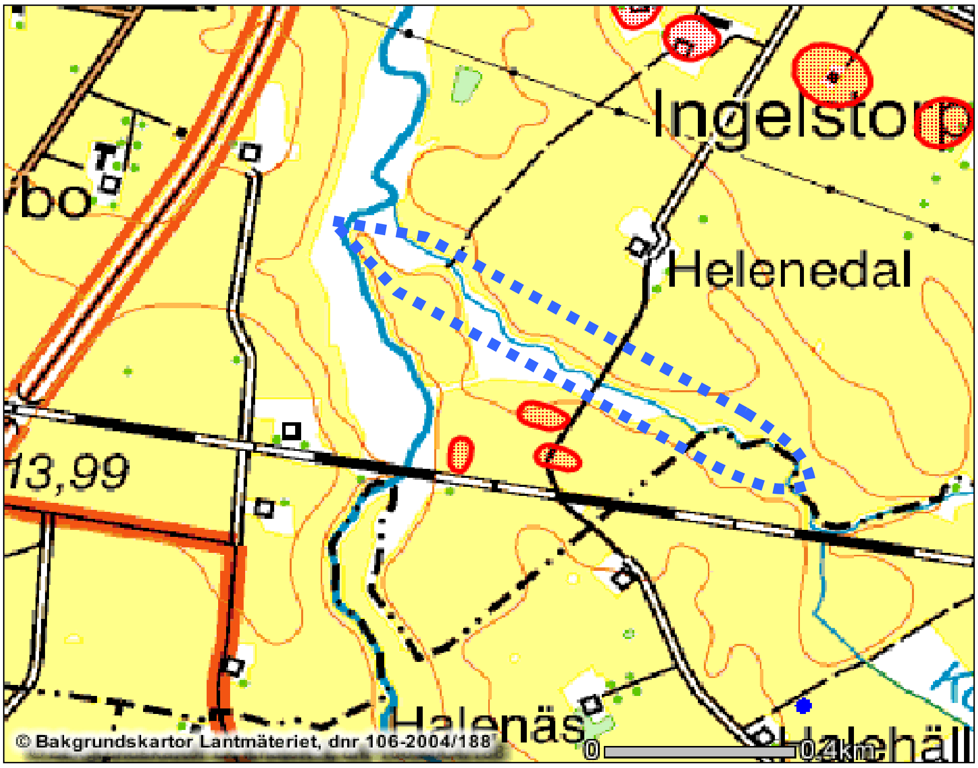

Figure 12 Location of three ancient remains at the delta of Vege river and Humle tributary
Source: Länsstyrelsen, 2008, http://kartor.m.lst.se/ims/website/Yttre%5FFornminnesregister/viewer.cfm

Infrastructure conflict

The existing roads and various lines/wires of different types of importance may cause a conflict of interests in the area. Often the wetland construction may go on if the size of the pool is justified and do not disturb infrastructures that are leading for example electric cables or telephone lines. Otherwise it is also possible to relocate communication poles a bit further. (Ekologgruppen 2004)

4.2 Discussions on wetland creation reasonability

4.2.1 Potential investors for wetland projects in Sweden

The existing financial sources for wetland projects is still remaining with Länsstyrelsen i Skania. However, environmental investments are assigned to wetland projects only if they will carry any “recreational” significance for the area. Another opportunity to get finances from Skania is to bond the wetland construction/restoration project with any kind of landscape planning, tourism, population, or nature preservation directed projects. Additional possibilities could be Rural Program for Sweden or Implementation Strategy for Southern Sweden projects. As these projects will be verified in Brussels they will lead to the new financing sources for wetland projects. (Länsstyrelsen i Skåne, 2207:5)

Alternatively, Ekologgrupen, the responsible body for Kävlinge river and Höje river wetland projects, updates that the average price paid as land compensation to landowners in mentioned catchments areas was 25.000 - 70.000SEK/ha in 1997, with the average of 40 000 SEK/ha. The land compensation rate varies as it is not the same for all kind of lands. In this aspect, quality of the soil, its classification scale (0-10 class) and geographical location are important factors for compensation matter. The land compensation is one-time payment paid by municipality and seen as a financial contribution to landowners which cannot be renewed. The contract between a landowner and Municipality is at least for 20 years.

It is interesting to mention that compensation rates are still in force independent of market price changes for lands (Annika Ekström, Ekologgrupen, Personal Communication). Anyway, there is an overall feeling that land compensation rates of 25 000 – 70 000 SEK/ha do not correspond to growing market prices and probably need to be revised by municipality board. For example, today market prices for lands located in Lund municipality area are about 200 000 SEK/ha (Annika Ekström, Ekologgrupen, Personal Communication), and 150 000 SEK/ha in Helsingborg area (Lars-Göran Persson, Vegeå Vattendragsförbund, Personal Communication).

Furthermore, there are additional financial supports from EU sources that may possibly motivate landowners for making changes in land use activities. For example, if landowners are interested to create a wetland in their land property it is common today that they also can apply for EU financial supports such as Stöd till Våtmarker (Wetland support), Stöd till Betesmarker o slåtteränger (Support for Permanent Grasslands), Gårdstöd (Farm Aid) or others (Jordbruksverket, 2008) besides the support that will be provided by their municipality. It is interesting to mention that rules for getting EUs financial support for agricultural and countryside activities, such as to create a wetland on their lands, were not been the same always (Annika Ekström, Ekologgrupen, Personal Communication). Earlier, landowners planning to establish a wetland had to apply for Wetland support only. Today, however, one can combine supports from EU and municipality for various agricultural and countryside projects on their lands (Jordbruksverket, 2008). For example, landowners planning to create a wetland, can obtain for about 3 000 – 7 000 SEK/ha/year from EU and 70 000 SEK/ha in average from Lund municipality if soil property has the highest quality and a good potential for wetland construction (e.g. low lying and wet areas). (Annika Ekström, Ekologgrupen, Personal Communication). Moreover, the following factors should be considered:

- if the farmland is being utilized as a grazing area
- if the farmer keeps animals around the farmland
- if the farmer takes good care of the land and cuts the grass

Jordbruksverket positively states that a landowner can possibly earn about 200 000 SEK/ha through EU financial support today depend on the geographical location and soil quality (Jordbruksverket, 2008), if he/she leases the land for wetland project.

4.2.2 The economic feasibility to build a wetland

As EQO of "Zero Euthrophication" suggests the nitrogen emission reduction target is possible to attain by 2010. The N reduction task set in 1995 was to reduce 56200 ton-N. In 2005 this target has been attained by 24 % of N reduction successes and has to carry on until reaching 30% of reduction rate by 2010. As measurements in the sea showed it is only 3 500 ton-N left to attain EQO for N reduction in the sea (Naturvårdverket, 2002).

Here, purposed actions and policy instruments considered by Swedish EPA in attaining present and new interim targets for EQO on "Zero Euthrophication" to reduce nitrogen and phosphorous emissions in the water are presented in Table 13.

Table 13 Complete summary of suggested measures by Naturvårdverket

Measure	Marginal Cost SEK/kg (Efficiency)		Potential ton (Effectiveness)		Total cost Million SEK/year
	N	P	Nitrogen	Phosphorous	
New Measures					
Reduced Cultivation	0-60		795 – 2 940	Possible in long-run	0 – 176
Mussel farming	36*	350*	450*	35**	16,2
Drainage	80-240	8 900 – 44 300	300***	2,6***	2 700 - 13 300
Filtering Ditches	?	6 400 – 33 300	?	1	6,5 – 33,3
Wood	38 -	19 000 -	220***	0,4***	8,4 – 17,6?
Dams/ponds	95**	948**	100***	10***	9,5
Existing measures					
Wetlands	37**	1 125**	1300**	4,3**	49
Catch Crops	99-350	?	500**	?	49,5 – 175
Protection zones		4 400 – 45 500	?	7,5***	32 – 341
Spring cultivation	64-73		500**		32-36,5
Complementary private sewers					
Coastal area	2 230**	9 640**	103**	24**	231

Inland area	1 840**	7 700**	88**	21**	162
Newly invested private sewers					
Coastal area	5 800**	29 990**	185**	35**	1 000
Inland area	4 780**	23 900**	158**	30**	700
Public facilities					
Coastal area	5 800**	29 990**	185**	35**	1 000
Inland area	4 780**	23 900**	158**	30**	700
		Total	**5 063- 7 267**	**236,1**	**6 700 – 18 026**

Source: Naturvårdverket, 2007

As presented measures are implemented they had revealed a potential for nitrogen reduction by 5100-7300 ton-N/year and P emissions by 236 ton-P/year, at the total annual cost of SEK 4100 – 4600 billion[2]. (Naturvårdsverket, 2007). It is observable from the table that wetland measure has the highest N reduction capability of 1300 ton-N/year at a total cost of SEK 49 billion and at the marginal cost of SEK 37kg-N. It means wetlands as N reduction measures approved by Swedish EPA are one of the most effective and one of the cheaper solutions to reduce N emissions in short time periods (i.e. 2010 by present interim targets and yet unknown date for new interim targets[3]). Can this measure be considered as cost saving measure for society?

In Figure 5, for Marginal Abatement Cost (MAC) curve developed from Table 11, there are illustrated the cheapest and most effective N reduction measures approved by Swedish EPA. MAC for various N abatement measures range from 0-5800SEK/kg-N.

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[2] SEK 6700-18026 billion is data obtained from Naturvårdverkets –Ingen Övergödning: Konsekvens analys delmål 1 och 2 draft version to the final Ingen Övergödning, 2007 December. The final report suggests SEK 4100-4600 billion, which will be used in discussions. (Naturvårdverkets, 2007)

[3] The present interim targets are to be reached by 2010. Only 3500 ton nitrogen remaining to me reduced in the sea to reach present interim targets. However by new interim targets a new time spect- rum yet to be proposed for N emission assignment which is still ongoing. (Naturvårdverkets, 2007)

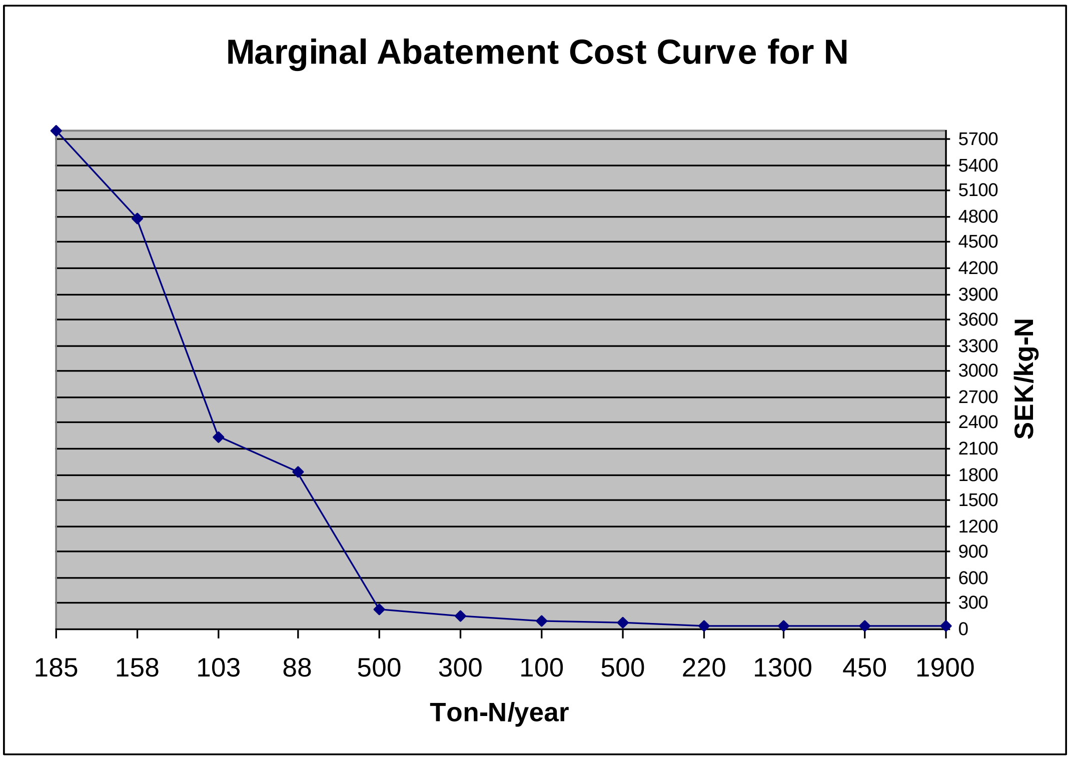

Figure 13 MAC in SEK/kg-N and reduction capacity (Ton-N/year) for various abatement measures

In this connection, Figure 6 depicts that the cheapest measures are lying under the price range of 0-300SEK/kg-N. Figure 6 is adopted from Figure 5 to reveal the MAC under 300 SEK/kg-N in relation to ton-N/year in more detail.

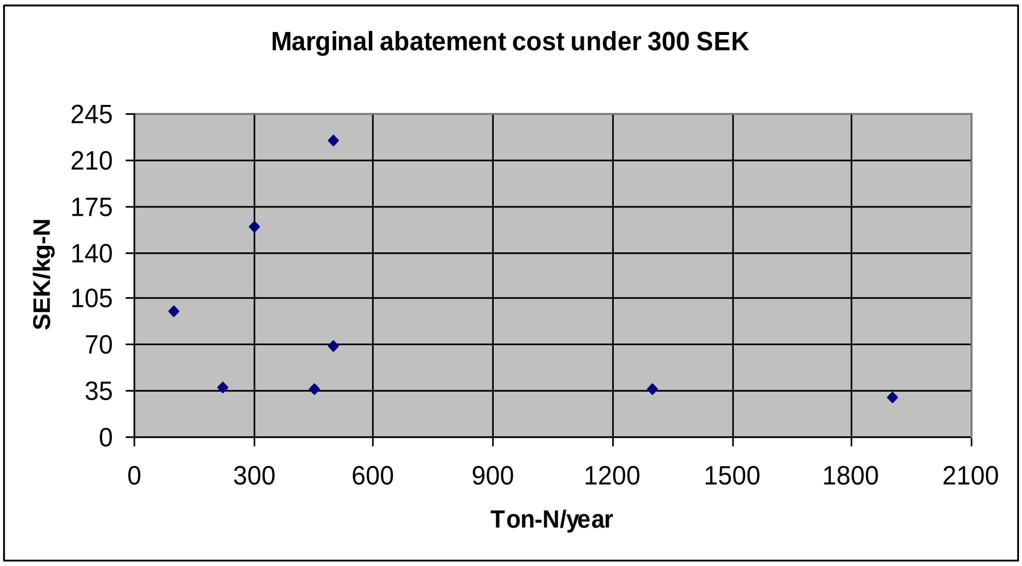

Figure 14 MAC measures under 300 SEK/kg-N with N abatement effectiveness up to 2100 ton-N/year (adopted from figure 5)

It is notable that for the society the cheapest and the most efficient measure with the reduction capacity at 1900 ton-N/year at the price of 30 SEK/kg-N in average is to cut back with agricultural activities.
However, considering the argument that it might not be possible to hold back the agriculture activities at least within one generation time frame, it is advantageous to explore the next best option for society in further.

The next best measure providing comparable efficiency and effectiveness to the first measure, are wetlands. They have reduction capacity for 1300 ton-N/year at the marginal cost of 37SEK/kg-N. They are the next cheapest and the most effective N reduction method approved by Swedish EPA.

Symbolically, if wetlands will be chosen as a major measure for N reduction at a national level they are capable of N reduction of about ¼ of total N reducing capacity of all measures taken together (5100-7300 ton-N/year), at a total cost of about 10 times cheaper than the total cost of all measures taken together (SEK 4100 – 4600 billion). This will lead to the saving of large expenses at a reasonable level of N reduction, and not only. The initiation of wetland measure is not only encouraging by its cost efficiency and reduction capacity numbers it is also provides with an important option - to keep up with agricultural activities. Besides, wetlands do carry great benefits for biodiversity sustaining and recreational interests in the region and generally increase these values by time. Wetlands has better land aesthetics and look much proper on the landscape than any wastewater treatment plant would do, being more efficient though. They are good hunting and fishing spots and in some cases may represent new income possibilities for local people.

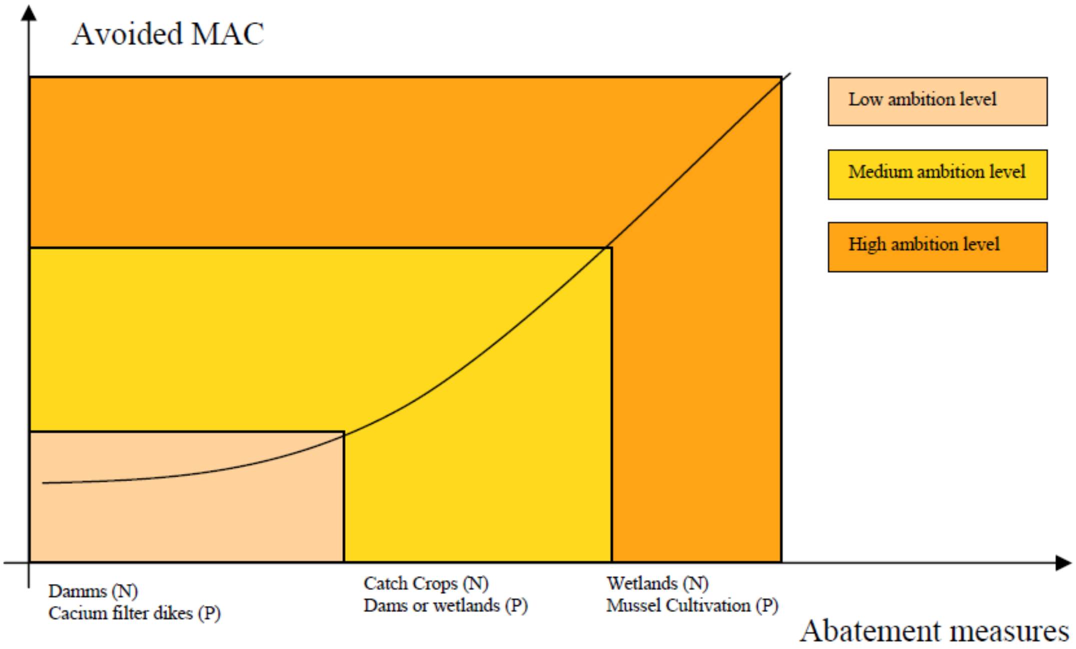

Figure 15 the interim target ambition levels grouped with relevant abatement measures

Figure 7 shows the avoided MAC in relation to N and P abatement measures in time spectrum of interim targets. This means that wetlands are both effective and efficient measures.

Having a more narrow look on Vege river case, suggested three wetland alternatives each will be able to uptake 2 – 3 ton-N/year (Persson O., 2007) at the total cost ranging SEK 3-10millions per wetland (See Table 11). To be able to reduce 1300 ton-N per year, it will be necessary to build around 530 wetlands with similar N reducing capacity of Vege river wetlands.

5 Conclusion

Today, there are various wetlands established in order to reduce nitrogen and phosphorous emissions in water and improve the water quality. The water policy documents such as EU WFD and national Environmental Quality Objectives (EQO) adopted by Swedish Parliament and many other efforts were made in recent decades to reach positive outcomes in euthrophication problem. As in regards nitrogen reduction, the task set in 1995 was to reduce 56200 ton-N would have been achieved by reaching 24 % of N reduction by 2005 and 30% by 2010.

Certainly, the roles of wetlands are greatly acknowledged in reducing nitrogen level in the water. In result, many wetlands projects were developed in Sweden in recent decades. But it is arguable whether it is the water policy or rational economical thinking that stands behind this kind of decision-making. Maybe both are? Does the decision-making actually consider utilizing data related to the economic valuation of nature in order to determine the feasibility of a certain wetland project?

This study indicates that Cost Benefit Analysis (CBA) is a very relevant tool in supporting the decision making whether to construct a wetland or not. CBA outlines those countless benefits from nature that increase human welfare at no cost in local and global scales. In particular, it is an influential practice providing quantitative values of resources and their services that do not have their market price, for example wetlands and most of their services.

Exploring the economic feasibility for Vege river wetland development through CBA was a task performed within this economic analysis. As a result, both advantages and disadvantages were explored while conducting CBA for Vege river wetlands. The great advantage was that the result of the analysis are based not only on cost attributes but also on benefit factors representing those huge values which often are left behind in our everyday decision-making. This provided a profound understanding of how actually the decision-making is being conducted and whether the environmental benefit-values of water bodies are being considered in decision making today. The explored disadvantage working with CBA was certainly the lack of necessary input data for various monetarised benefits attributes. In result, Net Present Value (NPV) calculations may suggest that it is economically not feasible to construct the wetland on Hulmle tributary today.

Communicating purely financially and considering **only** monetarised units that were possible to obtain, the results lead to the point that benefits expected to receive from Alternative 2 are closer to SEK 1.1 - 4.2 millions making this option more profitable for the society than alternative 1 and 3. Those alternatives are considered to be economically less reasonable and not feasible as they have resulted in SEK (-7)-(-4) million (negative value) and SEK 0.2 - 3.3 million respectively (See Table 10). However, these results are believed to reveal the matter only partly while the bigger picture is yet to be discovered. Primarily, this is because the lack of specific benefit data since it is impossible to attain or estimate environmental benefits and services of the wetlands during the timeframe of this study. Any fewer monetarised benefit data and attributes would optimistically change Total Benefit value leading to positive Net Benefit of the wetland creation.

In contrary, applied sensitivity analysis provides more insights in to this matter indicating the economical reasonability of wetlands for the society through its recreational value. In case of Vege river wetlands, it is considered that wetlands are being planned as nitrogen reduction measures only referring to their original purpose of construction. The sensitivity analysis suggests that if the wetland would have been planned and properly designed as a recreational area in addition to its function as nitrogen sinking pool it would have added some solid benefits to Vege river wetlands.

By introducing the wetland as a well functioning recreational area to the society members, it will potentially lead to an increased level of willingness to pay by them. It is due to the direct benefit for a society member to happily enjoy the increased aesthetic benefits of the area, improved environment and increased quality of life and possibly the prices of their property in the area. This clearly will add more environmental benefits to a society member and financial advantages to any wetland development project. The Willingness to Pay (WTP) value from Staffanstorp and Oxelösund wetland recreational areas has been transferred to find out the average WTP for the recreational value of Vege wetlands. Results of this indicated that the recreational interest in communities can have major potential to make Vege wetland development project economically feasible.

Another interesting argument is that all values attained in NPV examination are expressed in present values. And, it is known that all values increase over time. This also indicates that a wetland development project has the potential to become an economically reasonable investment with or without its recreational value.

Nevertheless, the sensitivity analysis also discloses that the wetland alternatives could be economically feasible exclusive of their recreational values. Assuming that the discount factor will not change over 50 years the cost indications show socio-economic profitability for Alternative 2 and 3 due to cheaper Marginal Abatement Costs (MAC). So, in case of no discount on value attribute over 50 years then the MAC for N reduction will be 25 SEK/kg-N for alternative 2 and 30 SEK/kg-N for alternative 3. Original MAC for any wetland is 37 SEK/kg-N as suggested by Naturvårdsverket.

Results from MAC of other measures (i.e. mussel cultivation, draining) than wetland over MAC factors of Vege river wetland indicate socioeconomic savings of SEK 17.5-26 mil/year, considering the discount factor 4% over 50 years, if the Vege wetland will be developed. As avoided MAC was brought in relation to N and P abatement measures in accordance of interim targets ambitions levels it yet again suggests that wetland solution is effective in cost and capacity abatement issues and can walk with interim target time-frames. The importance of the avoided MAC for future generation implies an application of new and all other known measures for N and P abatement as the most effective way.

It is therefore, this particular CBA study for Vege river wetlands comes to its conclusion stating that the development of wetlands as nitrogen sink pools as well as recreational areas will most likely turn into the socio-economically reasonable development project.

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APPENDICES

Appendix 1

The administrative infrastructure responsible for WFD according to data taken from WFD

Table 14 List of the governmental authorities and their responsibilities relevant to WFD in Sweden

Authority Name	Responsibilities
Swedish EPA	Central governmental agency for environmental policy and nature protection at the EU- and international levels. It reports to the commission and develops advices and regulations on WFD
National Geological Survey	This governmental board handles groundwater related issues. It also provides geological data and information necessary for the characterisation of water bodies.
21 County Administration Boards	They are responsible for administration and implementation of WFD. They also do regional environmental monitoring and supervision of all waters and for inspection and enforcement of all activities that may have an impact on water quality on water resources.
Municipalities	Share responsibility with number of governmental agencies fir ensuring compliance with legislation in the environmental area, water supply, water treatment and waste management.
Swedish 5 RBD	5 RBD are appointed to be regional authorities chaired by one county governor each RBD, according to WFD. RBD are responsible for decisions on environmental objectives, programs of measures and river basin management plans in their relevant RBD. They are also responsible for collecting necessary information within RBD, initiating regional and local cooperation and engagement in Water Councils.

Appendix 2

Yearly Nitrogen and Phosphorous emission levels in the Vege River

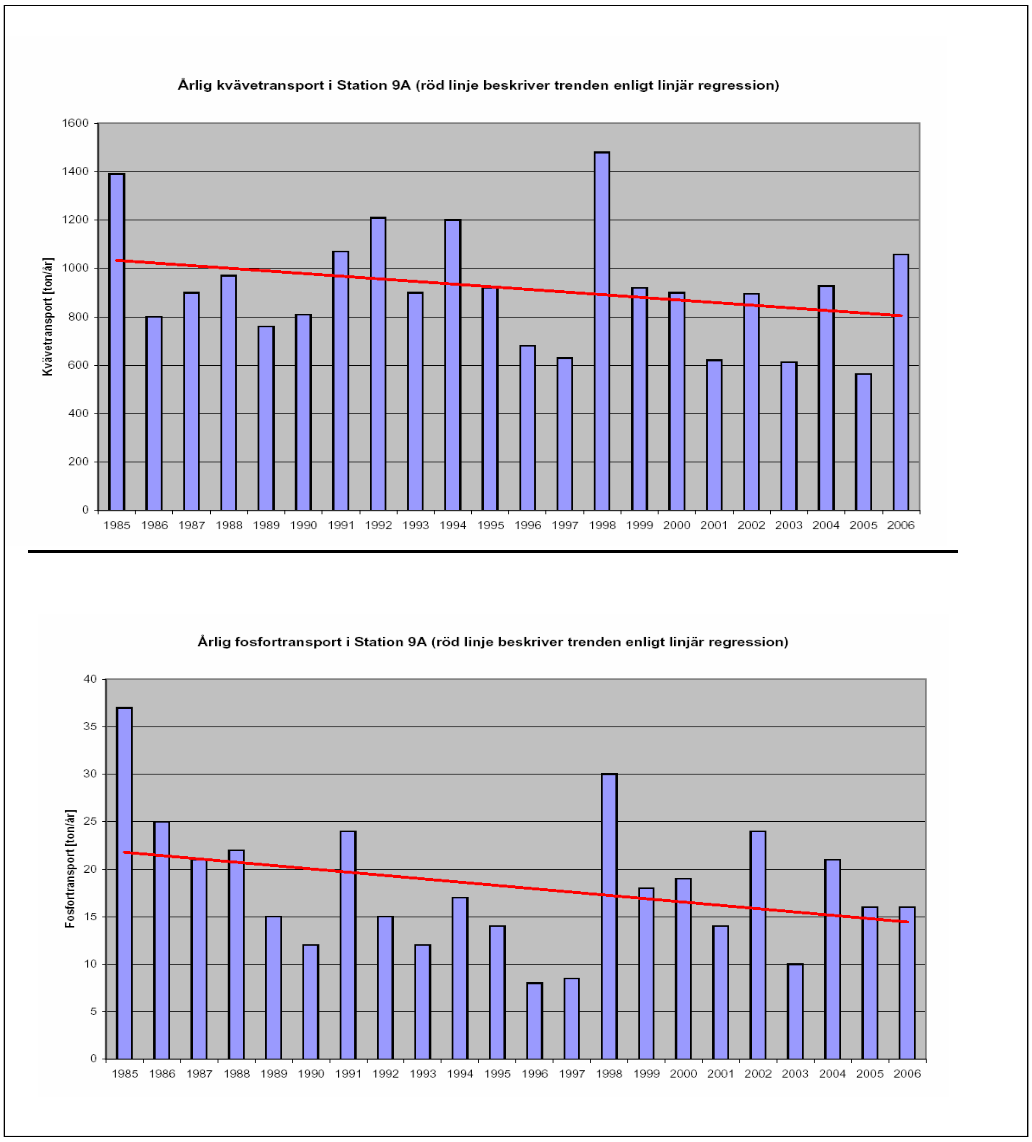

Figure 14 Yearly Nitrogen and Phosphorous emission levels in the Vege River water at the station 9A for the period of 1995-2006 (the red line illustrates the trend as a linear regression)
Source: Vegeåns Vattendragsförbund (Vege River Watercourse Association) Available at: *http://www.vegevatten.se/* *[accessed 15 November, 2007]*

Appendix 3

Wetland Functions in Nature and Related Benefits

Table 15 Wetland Functions and Benefits, Products and Services resulting from the wetland function

Functions Related to Hydrologic Processes	Benefits, Products, and Services Resulting from the Wetland Function
Short-Term Storage of Surface Water: the temporary storage of surface water for short periods.	Onsite: Replenish soil moisture, import/export materials, conduit for organisms. Offsite: Reduce downstream peak discharge and volume and help maintain and improve water quality.
Long-Term Storage of Surface Water: the temporary storage of surface water for long periods.	Onsite: Provide habitat and maintain physical and biogeo-chemical processes. Offsite: Reduce dissolved and particulate loading and help maintain and improve surface water quality.
Storage of Subsurface Water: the storage of subsurface water.	Onsite: Maintain biogeochemical processes. Offsite: Recharge surficial aquifers and maintain baseflow and seasonal flow in streams.
Moderation of Groundwater Flow or Discharge: the moderation of groundwater flow or groundwater discharge.	Onsite: Maintain habitat. Offsite: Maintain groundwater storage, baseflow, seasonal flows, and surface water temperatures.
Dissipation of Energy: the reduction of energy in moving water at the land/water interface.	Onsite: Contribute to nutrient capital of ecosystem Offsite: Reduced downstream particulate loading helps to maintain or improve surface water quality
Functions Related to Biogeochemical Processes	**Benefits, Products, and Services Resulting from the Wetland Function**
Cycling of Nutrients: the conversion of elements from one form to another through abiotic and biotic processes.	Onsite: Contributes to nutrient capital of ecosystem. Offsite: Reduced downstream particulate loading helps to maintain or improve surface water quality.
Removal of Elements and Compounds: the removal of nutrients, contaminants, or other elements and compounds on a short-term or long-term basis through burial, incorporation into biomass, or biochemical reactions.	Onsite: Contributes to nutrients capital of ecosystem. Contaminants are removed, or rendered innocuous. Offsite: Reduced downstream loading helps to maintain or improve surface water quality.
Retention of Particulates: the retention of organic and inorganic particulates on a short-term or long-term basis through physical processes.	Onsite: Contributes to nutrient capital of ecosystem. Offsite: Reduced downstream particulate loading helps to maintain or improve surface water quality.
Export of Organic Carbon: the export of dissolved or particulate organic carbon.	Onsite: Enhances decomposition and mobilization of metals. Offsite: Supports aquatic food webs and downstream biogeochemical processes.
Functions Related to Habitat	**Benefits, Goods and Services Resulting from the Wetland Function**
Maintenance of Plant and Animal Communities: the maintenance of plant and animal community that is characteristic with respect to species composition, abundance, and age structure.	Onsite: Maintain habitat for plants and animals (e.g., endangered species and critical habitats), for rest and agriculture products, and aesthetic, recreational, and educational opportunities. Offsite: Maintain corridors between habitat islands and landscape/regional biodiversity.

Source: US Army Corps of Engineers, 1995