LIFE Project Number

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Final Report

Covering the project activities from 01/01/2010 to 31/12/2012

Reporting Date

31/03/2013

LIFE+ PROJECT NAME or Acronym

CATERMASS

Data Project

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Project end date:	31/12/2012
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(%) of eligible costs	

Data Beneficiary

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2. Executive summary

Acid sulfate soils (AS-soils) are regarded as the most problematic soils in the world. Finland has Europe's largest areas of AS-soils (up to 3000 km2). These soils originate from anoxic basins in the former Baltic Sea where sulfate reducing bacteria converted sea water sulphate to sulphides in bottom sediments. Due to the strong land uplift (3-9 mm/year) these sulphide-bearing sediments have emerged above current sea-level. By reclamation, burning of the peat cover and heavy liming they nowadays constitute some of the most productive farm-lands in Finland. Meanwhile, due to these measures, the groundwater level is strongly lowered during dry spells, enabling oxygen to penetrate the soil. When exposed to oxygen, sulphides oxidize and produce sulphuric acid and make the soil extremely acid (pH 2,5-4), which in turn mobilizes enormous quantities of metals (including Al, Cd, Co, Ni and Zn) restored in the soil. Together with acidity, these metals are flushed from the soils into drains and recipient estuaries during wet spells. Metal discharges from AS soils are estimated to significantly exceed the corresponding industrial discharges from the entire Finnish industry. This is also the case for cadmium, one of the EU EQS directive priority substance metals. Moreover, cadmium concentrations also exceed the environmental quality standards in many waterbodies affected by AS soils.

In Finland, leaching of acidity and heavy metals from AS-soils is the most common cause for bad or poor ecological and chemical status of surface water bodies, affecting more than 30 coastal rivers and estuaries. Deteriorated or vanished fish stocks in numerous rivers and estuaries is the most visible effect. Impacts of acid runoff vary according to the quantity, quality and proximity of AS-soils and catchment characteristics of water bodies.

Climate change is likely to increase and widen the area of environmental damages unless targeted mitigation measures are developed. High peak concentrations of toxic compounds occur especially after long dry periods and subsequent heavy rainfalls. As a result of climate change, these hydrological extremes are expected to become much more common in river basins with small lake area and rapidly fluctuating discharges. For aquatic ecosystems and fish stocks this means increased probability for exposure to toxic metal compounds. The deeper layers of AS-soils also have high content of organic matter. Drying and consequent mineralization of these organic storages would lead to gaseous emissions (CO2, N2O, SO2).

The CATERMASS project (Climate Change Adaptation Tools for Environmental Risk Mitigation of Acid Sulphate Soils) aimed at developing climate change adaptation tools for the Finnish River Basin Districts to mitigate impacts of increased leaching of acidity and metals from acid sulphate soils drained for agriculture and forestry. The overall objective was to promote wide application of techniques and actions reducing acidity and metal concentrations in drainage waters, thus enhancing achievement of EU environmental objectives according to the Water Framework (2000/60/EC), Flood (2007/60/EC), Habitat (92/43/EEC) and EQS (priority substances) directives. Especially, our objective was to consolidate the knowledge base for adapting pollution control methods to the changing precipitation, runoff and temperature conditions.

The Main project objectives were:

to develop effective mapping, identification and risk classification methods of AS-soils.

to collate information on the loading levels and degree of environmental degradation in water bodies affected by AS-soils

to construct prototype testing fields with infrastructure and equipments (subsurface controlled drainage systems, pumping systems, tailored cropping and cultivation schemes) where we can demonstrate climate change adaptation tools under practical field conditions.

to assess the constraints for wide application of climate change adaptation tools as well as their socio-economic impacts and feasibility via participatory planning.

to demonstrate best environmental practices and tools for adaptation by pilot area excursions, seminars, guidance documents and www-techniques.

To address these objectives the following actions were carried out

Action 1: Mapping and risk classification of AS-soils
Action 2: Environmental impact assessment and risk scenarios
Action 3: Mitigation methods and their adaptation to the changing climate conditions
Action 4: Socio-economic impacts and participatory multicriteria analysis of adaptation tools
Action 5: Dissemination of the best environmental practices
Action 6: Project management

The key outputs of the project are:

-Free databases on the distribution, characteristics and ecotoxicological effects of AS-soils
-Estimates on climate change impacts on the environmental loading levels of metals and acidity
-Climate change risk scenarios of the ecological status of waterbodies
-Prototype experimental fields with infrastructure and equipments to demonstrate climate change adaptation tools under practical field conditions
-Multicriteria analysis of the socio-economic impacts and constraints of the adaptation tools
-Participation and co-operation forums and learning environments (via Regional watershed councils, web-pages) for assessment of climate change adaptation needs
-Guidance documents on identification of AS-soils and their risks and methods for mitigating adverse impacts.

Information about acid sulfate soils and about this project, a map showing the area to be mapped, a situation map and a guidance leaflet how to identify and characterize AS-soils in Finnish and Swedish were published on GTK:s web-site (www.gtk.fi). There is a map showing a preliminary interpretation of the probability for Acid Sulfate Soils in the whole potential area along the coast of Finland at the scale of 1:1.000 000. The first probability maps for major catchments at scale 1:250.000 and the classification of acid sulfate soils in Finland have been finished and are also available on the public server. The probability maps are considered to represent a data base. They show the probable distribution of AS-soils, the depth of the sulfide layer (at the observation sites) and by clicking on a site, a “site card” is shown. This card is a full description of the information for the specific site, including site information, photos, profile with description, pH, sulfur-content and risk classification.

The project has collected and analysed a vast set of water quality and benthic animal data which have been made publicly available through the OIVA database of Finnish environmental governance. The online service is free and requires only registration. Detailed description and instructions for the use are given in a publication placed on Catermass homepage (http://www.ymparisto.fi/download.asp?contentid=141964&lan=fi). The purpose of this database is to offer easy, online access to data for experts working in environmental issues or citizens interested in the effects of AS soils in Finland. The database collection has also been supported by the Ministry of Agriculture and Forestry.

A specific climate model constructed for the Finnish climate and environment was applied to estimate past and future metal discharges in River Kyrönjoki with the most extensive water quality monitoring data. The hydrological estimations were done for three periods following the existing climatic scenarios: 1971-2000, 2010-2039 and 2040-2069. The hydrological models yielded daily estimations of discharge for Skatila, which was averaged to four different seasons: year, spring (March-May), growing season (May-September) and autumn (October-December). The modeling indicated increased metal discharge at autumn when the flushing of the acid sulfate soils is at its highest and decreased discharge in spring and summer.

Controlling the groundwater level and its environmental impacts were studied on barley and wheat crops in the prototype experimental fields in Söderfjärden field and in Pedersöre field near Vaasa. Three different drainage methods were tested in Söderfjärden with a total area of eighteen hectares: i) conventional drainage, ii) controlled subsurface drainage and iii) controlled subsurface drainage combined with additional pumping of water in the summer. The results suggest that oxidation of sulfides can be diminished by controlled subsurface drainage, and the effect can be enhanced by pumping additional water from ditches into the drainage pipes, if there is risk that ground-water level sinks below the sulfide layer. Plastic film mounted into the ground and extending to the sulfide layer may effectively prevent water from escaping from the field. Combining these methods allow keeping sulfide layers in reduced state. Manual for mitigating environmental risks on acid sulfate soils using controlled drainage to control groundwater table was published in Finnish and Swedish.

The socio-economic impacts from different strategies to control the acid runoff from sulfate soils were evaluated based on data from river Kyrönjoki. Extending controlled subsurface drainage to all fields with conventional draining already installed, in river Kyrönjoki basin, would cost for the farmers around 2,7 M€ per year and controlled subsurface drainage combined with plastic film and subirrigation would cost around 3,7 M€ per year. Most of these costs come from increased labour costs for farmers. The costs for the Finnish Government from subsidies and investment support would be around 1,4 M€ and 1,8 M€, respectively. These costs can be compared with the annual agricultural subsidies of 12 M€. The costs from drainage restrictions and restoration depend on their implementation. If they are carried out through voluntary measures such as nature value trading, they can be economic solutions for some farmers. However, the farmers’ attitude towards all land-use restrictions was clearly negative and they were considered to have harmful impacts on the livelihood and farmers' identity and also on the local economy.

Dissemination of project results was efficiently done whole time during the project by web pages, press releases, published reports and by presentations and posters in national and international events:

Reports and publications:
- The impact of acid sulfate soils on water bodies and fish deaths in Finland
- Mitigating environmental risks on acid sulfate soils - Guide for controlling groundwater table
- Layman's Report
- Brochures 1

Seminars and workshops:
- National Kick-off Seminar for stakeholders
- Sub-projects seminars and workshops 10
- Lectures, presentations and posters in national and international seminars and conferences 35

Presentation of results in media:
- Articles in national and regional papers 26
- Radio presentations 2
- Fairs and other public events 1
- Press and news releases in the Internet 13

Websites and portals:
- www.ymparisto.fi/syke/catermass
Homepage of the project (in Finnish)
- www.miljo.fi/syke/ catermass
Homepage of the project (in Swedish)
- www.environment.fi/syke/ catermass
Homepage of the project (in English)
- http://www.catermass.fi
CATERMASS homepage information on acid sulfate soils

3. Introduction

Climate change may dramatically increase leaching of metals and acidity from geochemical soil anomalies having naturally high sulfur- and metal storages. In boreal river basins acid sulfate soils originating from sulfidic sediments starting to deposit during an early stage of the Baltic Sea (the Litorina Sea) about 8.000 years ago, are such anomalies. These soils cover up to 3 000 km2 of the coast of Finland mainly in low-lying agricultural and peat areas. Intensified agricultural drainage, especially subsurface drainage, has exposed sulfur-rich sediments to atmospheric oxygen, which leads to the formation of sulfuric acid in the soil, which in turn dissolves metals from the surroundings. This creates highly acidic and metal-rich runoff water, causing ecological degradation of water bodies especially in western Finland. The requirements of EU's Water Framework Directive cannot be met in this region the by the year 2015 because of the acid sulfate soils. Climate change is likely to widen the affected area and increase environmental damages. unless targeted mitigation measures are developed.

Hypothesis to be demonstrated was that by developing and demonstrating pollution control techniques tailored for changing climate conditions it is possible to mitigate the environmental impact of acid sulfate soils. Thus it is possible to enhance the ecological status of water systems damaged by acid load and metal-rich runoff water.

Description of methodological solution:

- increasing knowledge on the location, quality and quantity of AS-soils
- collating information on the loading levels and degree of environmental degradation in water bodies affected by AS-soils
- developing and testing groundwater controlling techniques on agricultural fields
- assessing socio-economic impacts and feasibility of the adaptation tools
- awareness rising and dissemination of results

Expected results of the project were to publish the collected data on the distribution end environmental effects of AS-soils as freely available databases with the guidance documents on identification of AS-soils and their risks. We also aimed to estimate climate change impacts on the environmental loading levels of metals and acidity and to set up prototype experimental fields to demonstrate climate change adaptation tools under practical field conditions. Manual for mitigating environmental risks on acid sulfate soils was produced. Project web pages and numerous presentations and press releases ensured the dissemination of information on project progress.

Environmental benefits

The direct impacts on environment of the whole project are: a) decreased loading of acidity, metals and potentially also greenhouse gas emissions from AS-soils, b) improved ecological status of the water bodies receiving effluents from AS-soils.

4. Administrative part

4.1. Description of the management system

General project management was run by Project office at Finnish environment centre SYKE, consisting of project leader, project coordinator and financial planner. The office and leader took responsibility on:

- administration together with administrative line organization of SYKE
- financial framework and follow-up
- reporting to EU Commission and co-financiers
- practical coordinating work between actions

A steering group, consisting of representatives of the beneficiaries, action leaders and advisory and farmer organisations, was established. Steering group supervised implementation of the projects and facilitates co-operation between actions. The responsibility of the steering group was to ensure together with the project leader, that the actions and their co-operation proceed according to the project plan. Advisory and farmer organisations were be asked to nominate advisory representatives to the group in order to ensure that views of stakeholders are taken into consideration in project implementation.

Project office organized three Steering group meetings (24.1.2011, 16.1.2012 and 12.12.2012)

Soon after project started Project office had to prepare Request for an Amendment to the Agreement (sent 22.4.2010) since the name of the one beneficiary was changed. At same time we requested a minor change in the financial structure concerning allocation of co-financier and EU contribution to partners. Amendment was approved by Commission 14.07.2010.

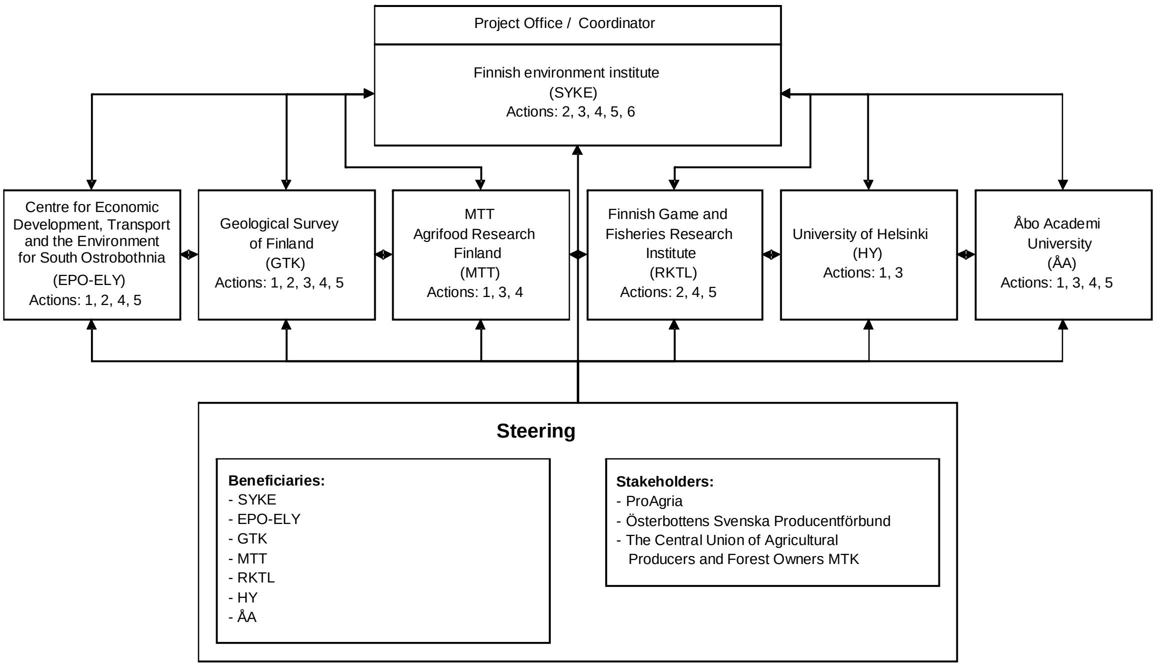
Project office conducted the preparation of obligatory reports to Commission:

- Interception Report 29.09.2010
- Mid-term Report 30.06.2011
- Progress Report 31.10.2012

Moreover Project office organized one monitoring visit with Commission representatives and three visits with external monitoring team:

- Jyväskylä 12.4.2010, Mr Pekka Hänninen
- Vaasa 29.-30.06.2011. technical desk officer Mr Federico Nogara, financial desk officer Ms Martine Ver-Eycken, Mr Pekka Hänninen
- Vaasa 17.4.2012, Mr Joonas Alaranta and Mr Bent Jepsen
- Helsinki 18.3.2013, Mr Joonas Alaranta

Project management structure is described in the organigramme below. Each action has a leader coordinating activities. Leaders are: Action 1 Peter Edén (GTK), Action 2 and 6 Kari-Matti Vuori (SYKE), Action 3 Eila Turtola (MTT), Action 4 Heli Saarikoski (SYKE), Action 5 Juha Riihimäki (SYKE).



Partnership agreement has been signed in seven copies by all beneficiaries (EPO-ELY: 23.04.2010, GTK: 27.04.2010, MTT: 27.04.2010, RKTL: 05.05.2010, HY: 26.04.2010, ÅA: 03.05.2010, SYKE: 22.04.2010). It has been submitted to the Commission with the Interception Report (28.09.2010).

The partnership agreement (in Finnish) covers the following issues:

1. Subject of the agreement
2. Parties of the agreement
3. Documents of the agreement
4. Purpose and duration of the agreement
5. Responsibilities of the parties
6. Implementation of the project
7. Reporting and payment of the funding portions
8. Management of the project
9. Rights to use the background material
10. Confidentiality
11. Ownership and rights to use the result material
12. Force majeure
13. Solving disputes
14. Contacts
15. Signatures

4.2. Evaluation of the management system

Project management system was efficient although we had some difficulties to keep up with the planned deadlines of some deliverables.

Action 1: Publication of the common, free database on distribution and characteristics of AS-soils in Finland together with maps on the distribution and risk classification of AS soils in Finland was delayed because GTK's new public Image Web Server on www.gtk.fi, which was promised to the beginning of 2013, has not been finished due to reasons independent of our team. Acid Sulfate Soils map services is among the first themes to be published at the end of March 2013.

Action 2: Publication of free www-database on the ecological and ecotoxicological effects of AS-soils was done as planned but because of mixed information the detailed description and instructions how to use the database was published at web pages the February 2013.

Action 4: Comprehensive overview of the ecological, economic and social impacts of alternative adaptation tools was delayed due the difficulties in analysing the ecological impacts of alternative adaptation tools. This affected to rest of the work and the final results was reported at March 1013.

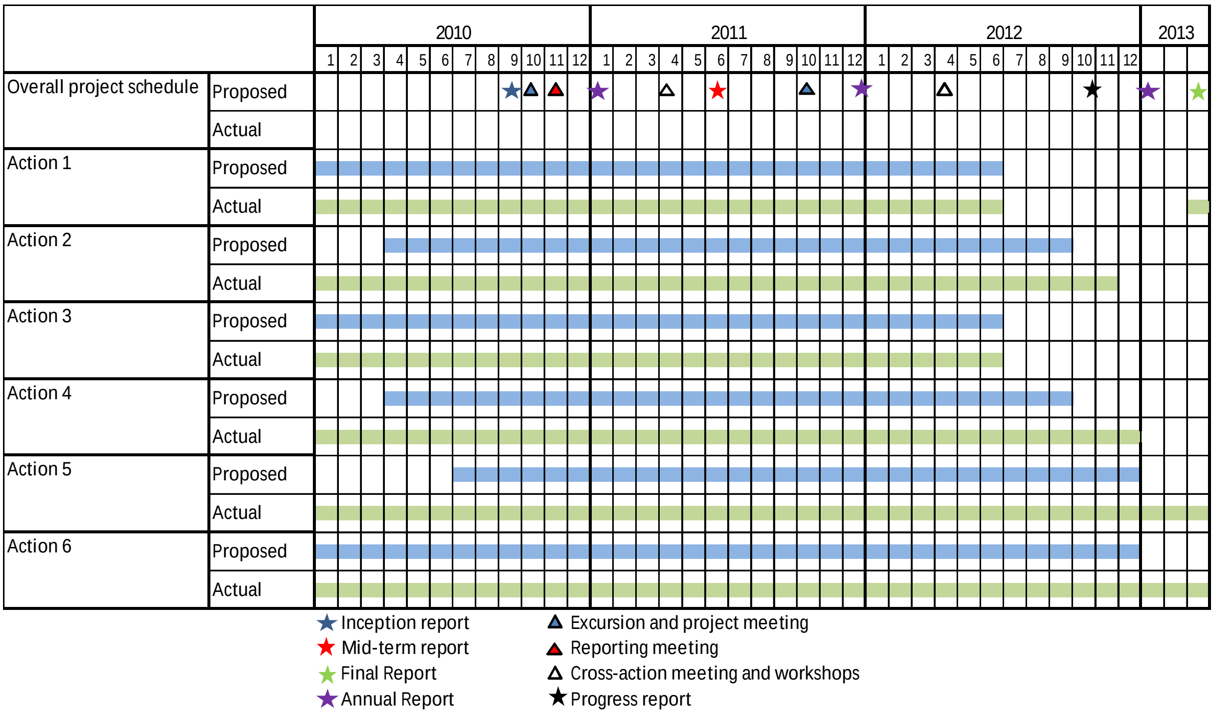
Action 5: Layman's report was postponed to wait final results of other Actions and it was finalized at the March 2013.

Dissemination activities were effective consisting mainly of effective use of web pages, several meetings with stakeholders, demonstrations given at the prototype fields and presentations and posters at the international and national seminars. Totally 11 seminars or workshops were arranged by the project, 35 presentations or posters were presented in other events and 27 press articles was published. Project published also 13 press releases in internet.

Continuation of the project as described on After LIFE communication plan. The mapping activities of AS-soils developed and started during the project are continuing for years on. The web pages will be updated also after the project as we produce more data and maps, information and educational material. Annual monitoring of AS-soil impacts in waterbodies continues at 10-15 monitoring sites (monitoring carried out mainly by ELY-centres as a subproject of the national WFD monitoring. The demonstration fields will be kept in action and available to public. In Söderfjärden, the project continues at least for 18 months. The project results will be available in Internet (http://www.CATERMASS.fi and http://www.ehp-data.com). The final results of action 4 will be presented in River Kyrönjoki and River Lapuanjoki Watershed Council meetings in spring 2013. The Watershed councils are stakeholder forums consisting of key local stakeholder organizations and both councils have been actively involved in carrying out the participatory integrated appraisal in Action 4.

5. Technical part

Gantt-chart below illustrates proposed and actual progress of CATERMASS project



5.1. Task by task – description

5.1.1. Action 1 Mapping and risk classification of AS-soils

Expected results:

1	A common, free database on distribution and characteristics of AS-soils in Finland	
2	Maps on the distribution and risk classification of AS soils in Finland (electronic www-publications and leaflets)	
3	A guidance document on how to identify, characterise and map AS soils	

The main tasks of Action 1 were to increase knowledge on the extent, depth and quality of acid sulfate soils (AS-soils) by developing cost-effective mapping tools and risk classification to produce maps on the distribution of these soils. The results will be published as free on-line databases on the distribution and characteristics of AS-soils.

The first year was mainly method development. The area where acid sulfate soils are expected to occur, is very large, more than 5.000.000 ha. Therefore we started by developing screening techniques in order to narrow down areas of interest. Such techniques involve processing of existing databases and available landscape data in GIS (airborne geophysical data, soil maps, bedrock geological maps, peat-bottom soil information and topographic data including LIDAR surveys) to delineate areas potential for ASS. This multivariate analysis creates a probability map showing in broad outline the areas potential for AS-soils. This map is used for planning of field sampling programs for individual catchment areas.

Systematic mapping and classification of AS-soils started in 2010 with GTK as responsible partner and in co-operation with Åbo Akademi University and the University of Helsinki. The procedures and equipment were tested and improved during work, and the measurements and analytical results were used to improve the multivariate analysis. Two-six persons (1-3 pairs) were doing field work from May to September. Profiles for detailed lithological observations and sampling, as well as reconnaissance probe drillings were made to 3 meters depth. On the basis of observations, measurements and analyses, we made a classification, a guide and maps, which are available for the public on GTK’s web-pages.

Field mapping continued during the summers of the whole project period and two-six persons (1-3 pairs) have done field work from May to September 2010-2012. During this period we have collected information down to 3 meters depth from more than 7.000 sites. These include:

- 594 profile sites (using an auger sampler to 300 cm depth, determining soil type and soil properties, Munsell colour, ground-water level, measuring pH and collecting samples for every 20 cm)

- about 6.400 “reconnaissance” sites (quick profile description using a thin, 2 m long stick with a soil sampler of 40 cm in the lower end)
- more than 2.000 samples analysed for Sulfur and 30 other elements (Aqua-Regia leach, ICP-OES)
- incubation (oxidation up to 16 weeks) of the samples to measure final pH

The information has been saved straight from the field computer and from the laboratory to the databases of GTK.

During the mapping process and in several workshops we have developed a model for maps, and a definition of Finnish Acid Sulfate Soils and a (risk) classification system for them. Both differ considerably from the internationally used ones (WRB and Soil Taxonomy). The different approach in Finland is a result of the different characteristics and way of formation, the Boreal environment and of observed / measured qualities leading to harmful impacts on the environment.

Results of the AS-soil mapping (annex 1, annex 2 in the August 2012 Progress report) and the definition - risk classification (annex 3) were presented at the 7th International Acid Sulfate Soil Conference in Finland in August 2012. Representativeness of mapping and risk classification was further tested using data from an older nationwide survey and presented at the same conference (annex 4 in the August 2012 Progress report).

Information about acid sulfate soils and about this project, a map showing the area to be mapped, a situation map (annex 1) and a guidance leaflet in Finnish and Swedish (annex 2) have earlier been published on GTK:s web-site, www.geo.fi. More and new material will be published by the end of March 2013. This publication was delayed because GTK’s new public Image Web Server on www.gtk.fi, which was promised to the beginning of 2013, has not been finished until now due to reasons independent of our team. Acid Sulfate Soils map services is among the first themes to be published. There will be a map showing a preliminary interpretation of the probability for Acid Sulfate Soils in the whole potential area along the coast of Finland at the scale of 1:1.000.000 (annex 3). The first probability maps for major catchments at scale 1:250.000 and the classification of acid sulfate soils in Finland have been finished and will also be available on the public server (annexes 1 and 2 in the August 2012 Progress report!).

The probability maps are considered to represent a data base. They show the probable distribution of AS-soils, the depth of the sulfide layer (at the observation sites) and by clicking on a site, a “site card” is shown. This card is a full description of the information for the specific site, including site information, photos, profile with description, pH(field) and pH(incubated), Sulfur-content and risk classification (annex 4).

Spatial data from the project will be stored, made available and maintained according to the guidelines of the EU INSPIRE Directive, as soon as the ongoing work to establish this in Finland is finished. AS-soils will be included as natural risk areas (Natural Risk Zones, NZ, Risk Or Hazard Category).

5.1.2. Action 2 Environmental risk assessment and risk scenarios

Expected results

1	Free www-database on the ecological and ecotoxicological effects of AS-soils	
2	Detailed description and mapping of water bodies affected by acid and metal runoff from sulphate soils, including: a) exposure profiles (degree of loading, pH- and metal levels, frequency and duration of acid peaks), effect profiles (degree of deterioration of the ecological status of biological quality elements, degree of ecotoxicity)	
3	Estimates on the development of the ecological status of water bodies following the implementation of the water protection measures	
4	Scenarios on the impacts of climate change on leaching of acidity and development of ecological risks	
5	Monitoring network and database enabling fast delivery of information on acid load to end users, who can use the information for adjusting protection methods	

5.1.2.1.Ecotoxicological risk assessment of estuary sites affected by ASSs.

While ASSs effects on river ecosystems are well known, knowledge on impacts in estuaries is scarce. We conducted an ecotoxicological risk assessment in 14 Ostrobothnian river estuaries affected by ASS hotspot area based on exposure assessment and some ecological effect profiles, and we used multiples lines of evidence approach to finally characterize the ecotoxicological risk of ASS-affected estuaries.

Estuary water resembles river water at high discharge. The river water cadmium (Cd), nickel (Ni) and lead (Pb) concentration comparisons to environmental quality standards (EQs) indicated Cd concentrations were exceeded during 3/2009 – 9/2010 at River Kyrönjoki, R. Maalahdenjoki and R. Närpiönjoki while the concurrent pH minima at the estuaries were 5,0, 4,3, and 5,5 respectively. Toxicity tests (kinetic Vibrio fischeri luminescence inhibition test for acute toxicity and chronic toxicity test with midge larvae Chironomus riparius) for the estuary sediments were completed and supplemented with metal concentration data for the sediments and river waters, and benthic invertebrate community quality data exposed on the spot to acidity and metals to produce various endpoints for the integrated risk assessment. Hazard quotients (HQs) for aluminium (Al), zinc (Zn) and Cd were generated using USEPA ECOTOX database, and the HQs revealed that Al seemed to be one major problem in the studied estuaries affected by ASSs. Metal concentration normalization to a standard sediment containing 10% of sediment organic material (as loss of ignition) and 25% of clay on a dry weight basis revealed 6 of the estuary sediments had negligible metal pollution levels, 8 were elevated, and 3 of the sediments were clearly contaminated according to the national criteria (2004) at the time of our sediment sampling. By joint treatment of assessment endpoints we generated a four-tiered time-conditional (2010) ecotoxicological risk classification for the 14 estuary areas that yielded bad status in 5 of the studied estuary sites, passable/fair in 6 of them, and good in only 3 of the studied estuary areas.

Results that are available at Catermass website have been presented in the International Acid Sulfate Soil Conference at Vaasa (August 29th 2012) and in a workshop directed to the planning of the Gulf of Finland year 2014 in Helsinki (November 12th-13th 2012), and will be presented both in a meeting of the Limnological Society of Finland in Helsinki (April 11th 2013) and the 11th meeting of the Finnish Conference of Environmental Science in Tampere (FCES; May 2nd-3rd 2013). This ecotoxicological risk assessment of estuary sites affected by ASSs has been drafted to a manuscript, and will be shortly published in a scientific journal.

5.1.2.2.The ecological and ecotoxicological effects of AS soils.

The project has collected and analysed a vast set of water quality and benthic animal data which have been made publicly available through the OIVA database of Finnish environmental governance. The online service is free and requires only registration. Detailed description and instructions for the use are given in a publication placed on Catermass homepage (http://www.ymparisto.fi/download.asp?contentid=141964&lan=fi). The purpose of this database is to offer easy, online access to data for experts working in environmental issues or citizens interested in the effects of AS soils in Finland. The database collection has also been supported by the Ministry of Agriculture and Forestry. There are 65 locations altogether providing comprehensive set of AS soils related parameters (e.g. pH, alkalinity, temperature, turbidity, colour, sulfate) and metals (e.g. As, Co, Cd, Zn, Mg, Pb). Ecological effects can be studied via benthic animal species lists, semi quantitative abundances and indices. Many of these locations are part of the existing environmental monitoring network and new data will be added regularly increasing our knowledge on effects of AS soils beyond this project. The interpretation of datasets may need expert knowledge to be efficient, correct and useful. Therefore, we have compiled two documents available online based on this dataset and other existing sources which are shortly introduced in the next section.

A comprehensive review of the impacts of acid sulfate soils (ASS) on water quality, biota, and fish kills in Finnish water bodies was completed and published in May 2012 (Annex 6a, only documentation page: in the August 2012 Progress report!). This review is a result of extensive collaboration among research scientists. Acidity and the attendant proliferation of toxic forms of metals induce changes in all organism groups of water biota, among them fish, macroinvertebrates, macrophytes, and bottom algae. On the specimen level, malformations have been discovered, such as structural pupae impairment in aquatic insects. Fish kills in rivers, lakes, estuaries, and coastal waters due to ASS soils were catalogued as comprehensively as possible. This listing is further proof that the problems are concentrated in the region of Ostrobothnia. Fish have been practically extinct in the minor rivers most afflicted with acidity and toxic metals in recent decades. The publication is available on the internet: http://www.ymparisto.fi/default.asp?contentid=417769&lan=fi.

A report document on water quality monitoring (Annex 5, abstract page) http://www.ymparisto.fi/download.asp?contentid=138541&lan=fi conducted 2009-2011 in rivers Siikajoki-Luohuanjoki, Kyrönjoki-Lehmäjoki ja Maalahdenjoki together with conclusions was finalized and will be further exploited when reporting ecological and chemical status of Finnish surfacewaters to the Ministry of Agriculture and Forestry. Elevated metal levels, that occasionally exceed Environmental Quality Standards set by the WFD (Cd, Ni), and low pH are strongly bound to discharges indicating water shed area influence and ASS exposure. The pdf compilation is available in the Catermass home page. These documents improve the accessibility and increase the understanding of the effects of AS soils in environment and should thus serve as important first level information sources.

A comprehensive review of the impacts of acid sulfate soils (ASS) on water quality, biota, and fish kills in Finnish water bodies was completed and published in May 2012 (Sutela et al. 2012). This review is a result of extensive collaboration among research scientists. Acidity and the attendant proliferation of toxic forms of metals induce changes in all organism groups of water biota, among them fish, macroinvertebrates, macrophytes, and bottom algae. On the specimen level, malformations have been discovered, such as structural pupae impairment in aquatic insects. Fish kills in rivers, lakes, estuaries, and coastal waters due to ASS soils were catalogued as comprehensively as possible. This listing is further proof that the problems are concentrated in the region of Ostrobothnia. Fish have been practically extinct in the minor rivers most afflicted with acidity and toxic metals in recent decades. The publication is available on the internet: www.ymparisto.fi/syke/publications.

Fish sampling by electrofishing in wadable river rapids was performed in August-September 2010-2012. Each sampling site (average area 133 m2, range 30-335 m2) was fished once from downstream to upstream by a two member crew equipped with battery powered gear. Around 45 sites were sampled annually in 2010 – 2012 yielding a total of 136 electrofishing results. Additional electrofishing results (about 70) were collected from other sources. Electrofishing data from 2010 and 2011 was processed and related to pH and some other water quality parameters. Results indicated clear responses of riverine fish communities to acidity and toxic metal concentrations. Tolerant fish species, such as perch and pike, were recorded frequently in nearly all of the studied rivers with average pH range 4,5 - 7, whereas intolerant species, especially bullhead, grayling, brown trout and minnow, were usually not found in rivers with average pH less than 6 (Figure 1). As an extreme case, River Vöyrinjoki with average pH of about 4,5 was discovered fishless in our sampling.

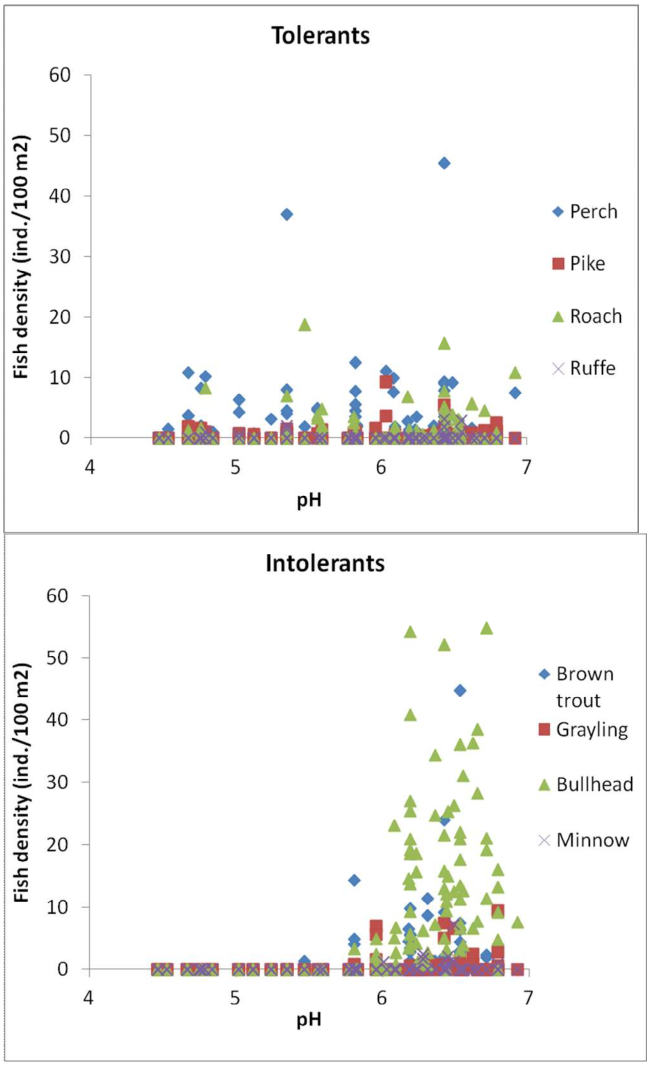


Figure 1. Density of four tolerant and intolerent fish species in relation to average pH in the studied rivers.

5.1.2.3.Climate change and AS soils

Climate change and water quality scenarios.
A specific climate model constructed for the Finnish climate and environment was applied to estimate past and future metal discharges in River Kyrönjoki with the most extensive water quality monitoring data. The hydrological estimations were done for three periods following the existing climatic scenarios: 1971-2000, 2010-2039 and 2040-2069. The hydrological models yielded daily estimations of discharge for Skatila, which was averaged to four different seasons: year, spring (March-May), growing season (May-September) and autumn (October-December). Concentrations of alkalinity, cadmium, lead and nickel and pH were acquired from HERTTA database maintained by the Finnish Environment Institute. We used multiple linear regression preceded by principle component analyses (PCA) to quantify which water quality variables were significant to each metal. The PCA was used to extract independent explanatory variables due to strong multicollinearity between water quality variables. The future metal

concentration models were evaluated by comparing empirical and modelled values using bivariate correlations.

Yearly discharges were predicted to increase slightly. For spring and growing season, discharges were modelled to decrease clearly from the control period but an evident increase in discharges was found in autumn. Alkalinity, COD and colour correlated with PCA2 and alkalinity, discharge, pH, suspended solids and turbidity with PCA1. Both PCA1 and PCA2 were significantly related to all metals in year study period and PCA2 affected aluminium, cadmium and nickel during autumn season based on linear multiple regressions.

As the magnitude of metals leaching from AS-soils is directly related to water discharges, modelling was extended to estimate future metal concentrations for Cd, Zn, Al and Ni. As expected, preliminary values corroborate the assumption that average river water metal concentrations will increase at autumn when flushing of the AS-soils is at its strongest. For example, the average concentration of Cd increased from 0,139 µg/l in control period to 0,146 µg/l in 2010-39 and 0,155 µg/l in 2040-69. This water quality scenario dataset, currently available as a manuscript will be published in a scientific journal.

Modeling the efficiency of drainage practices on acid sulfate soils at present and future climates at river Kyrönjoki.

One of the main goals of the Catermass project was to develop new drainage practises for the AS soils to mitigate acidic leaching. The success of these practises were assessed by applying the ionic flow model HAPSU developed in 1996 to simulate SO_4, H^+, Fe, Ca^{2+} and Al leaching from the runoff areas of AS soils and non-acid soils in boreal conditions. The HAPSU model was used for comparing the long-term efficiency of the different water protection practices to discharge water quality in the runoff area of Rintala by river Kyrönjoki. The observed water protection practices were controlled drainage (CD), lime filter drainage (LFD), and their combination (LFD + CD). Also the effect of subsurface pumping in addition to CD (CPD) and installation of plastic sheets in the soil to prevent lateral flow was estimated roughly. The simulations were done for the reference period 1990-2010 and scenario period 2010-2030. The scenario simulations were done by utilizing the temperature and precipitation data calculated by the experts of SYKE for the period 2010-2039 with the A1B climate scenario, which is an average of 19 GCMs.

The model was able to show the effectiveness of water protection actions in water quality. Also, the simulated pH and metal values were noted to be in line with the measured values. Our simulation showed that the CD method had only a minor effect on the simulated pH of discharge water in both periods, 2000-2010 and 2010-2030. The efficiency was improved when the LFD method was used simultaneously with CD method and in the long-term simulations the effect fortified slightly. In the CPD groundwater level can be kept high also during dry periods by pumping extra water into the drains and the results probably will be even better. The simulated leaching of SO4 from AS soil area showed the decreasing pattern in the 21 year period. Simulated values were in line with the measured ones, but simulated metal concentrations had a high variation. The complete report (Kosunen 2012) is available online and the results were presented in the International Acid Sulfate Soil Conference at Vaasa, Finland (August 29th 2012) as a poster (Annex 6). A scientific publication is under preparation.

5.1.2.4.The effect of landscape level use on the water quality in different rivers.

A large water quality data set was compiled from the SYKE Hertta database for selected rivers. The purpose is the compare quantitative landscape level actions and soil type (AS-soils, peatlands, mineral soils etc.) on the existing water chemistry and metal concentrations. The landscape data is based on Corine land cover inventory (2006) satellite data that divides land cover used for e.g. agriculture, forest types and constructed areas per square meter basis. The hypothesis is that land use activities (e.g. agricultural activities and forest ditching) can influence the metal concentrations in rivers. The results can enable estimation of environmental effects of catchment area land use activities in rivers which, in turn, can be used as a tool in environmental impact assessments.

Furthermore, in addition to water chemistry, ecological values like diatom and benthic animal indices as habitat quality indicators will be connected to land cover analysis. This approach is possibly giving us quantitative information on reasons behind widely existing pH and metal stress factors responsible for habitat deterioration. The analysis may give us a chance to estimate plausibility of protective actions, e.g. different drainage systems of agricultural fields. This dataset is available and the analysis will be performed in March-April 2013 with the help of Japanese visiting researcher specialized to statistical methods in geographic information systems (GIS). This work will produce one international scientific publication.

5.1.2.5 Application of Biotic Ligand Model in estimating fate and effects of metals.

Metal bioavailability and toxicity have long been recognized to be a function of water chemistry. For example, organic matter and inorganic substances can form complexes with metals and thus reduce metal toxicity. Therefore, metal toxicity can vary a lot depending on the water chemistry when expressed as total or dissolved metal concentration (the EU WFD). Instead, free metal ion concentration can be directly linked to bioavailable concentration responsible for toxic actions. Biotic Ligand Model (BLM) is developed to incorporate metal speciation and the protective effects of competing cations into predictions of metal bioavailability and toxicity.

The model develop by the HydroQual (NJ, USA) was used as a BLM software to calculate speciation and toxicity of cadmium in the River Kyrönjoki site Skatila. This location was selected because the model required water quality parameters, that are not measured routinely in the monitoring programs, were available here and because the site has high Cd concentrations (average 0,11 ug/L, 2010-2012) that even influence on the ecological classification guided by the WFD. The results indicate that the free metal Cd ion concentration is on average 46% of the total dissolved Cd concentration in a river 2010-2012. The model is also able to calculate what would be the Cd concentration in water if acute (lethal) effects were expected. For a fish (rainbow trout) average concentration 2010-2012 would be 10,0 ug/L and for a water flea as high as 243,5 ug/L. These calculations are preliminary but clearly show that understanding metal behaviour in a system will improve the risk assessment and could have implications for the implementation of WFD. The dataset is also useful in the BLM validation actions currently performed in the EU and Finland as well. These results will be presented in a meeting of the Limnological Society of Finland in Helsinki (11.4.2013) and a research project is under planning to investigate the role of the BLM in monitoring and classification work of Finnish water bodies.

5.1.3. Action 3 Mitigation methods and their adaptation to changing climate conditions

Expected results

1	Manual, including technical guidance on how to manage controlling subsurface drainage systems in order to maintain high groundwater levels and reduce leaching of acidity	
2	results of the response of crops to high groundwater level	
3	recommendations for water management in agricultural acid sulphate soils with different depths of the sulphide layer	
4	tentative results of these mitigation methods on runoff water quality and greenhouse gas emissions	

The objective of the Action 3 was to demonstrate technical and practical solutions for maintaining high groundwater level and adapting land use to climate change The environmental effects of high groundwater table on nutrient and metal leaching were also monitored in two prototype test fields (demonstration fields of Söderfjärden and Pedersöre) by the MTT Agrifood Research Finland (MTT), Åbo Akademi (ÅA) and Centre for Economic Development, Transport and the Environment (ELY Centre) and using 1-m-high acid sulphate soil monolites in controlled experimental conditions at Viikki Campus of the University of Helsinki. The aim was to raise the groundwater level at the demonstration sites and monitor the effects of the elevated ground water level on the soil, pH and concentrations of nutrients and metals in drainage water (or soil water in lysimeter site), greenhouse gas emissions and the response of cultivated crops to elevated groundwater level. In demonstration fields the summer period was rather dry especially in 2010 and 2011 allowing the decrease of groundwater level and increasing oxidation of sulphidic layers and thus increasing acidity discharge and leaching of heavy metals and aluminium. Acid drainage waters with high metal concentrations were measured. This effect was mitigated by controlled drainage systems, with additional water pumping and installing a vertical plastic sheet along main ditches to prevent water flowing back from the field to the ditch. In the lysimeters, high water table (water level right below the plough layer to submerge the actual acid sulphate horizons and keep the sulfidic materials continuously water-logged) or low water table (water level decreasing to the sulfidic soil horizon) was applied. The treatments in the lysimeter experiment corresponded to the 1) controlled drainage + pumping and 2) conventional subsurface drainage in the field, respectively.

The Söderfjärden demonstration field (18.4 ha) with three different drainage systems (controlled drainage system with additional pumping of water to drainage pipes during dry periods to evaluate the groundwater level, controlled subsurface drainage system without pumping of water, and conventional subsurface drainage) was established within this project in cooperation with MTT, local farmers and the advisors organization (Rural Advisory Centre of Ostrobothnia, ProAgria) on silt loam soil near the town of Vaasa in spring 2010. The oxidation depth extended to ca. 1.7 m from the soil surface. Two of the plots had a previously installed controlled subsurface pipe drainage system. On the third plot (conventional subsurface drainage), some improvements were made in

May 2010. In the end of September 2010, 3 gauges for continuous measurement of drainage water outflow from the plots as well as pH and electrical conductivity (EC) in outflow were installed. At the same time the instruments for the continuous measurement of groundwater level, soil temperature and moisture at depth of 30 and 70 cm and were installed. Since that the rainfall, air temperature and moisture have been measured continuously in the field. The data of these measurements can be followed in the internet through the address of http://www.ehp-data.com or http://www.catermass.fi. Spring barley (2010 and 2012) and spring wheat (2011) were grown on the field. The plots were cultivated with similar practices by the three farmers. Already before the CATERMASS-project the drainage system in the larger area of Söderfjärden was planned by Rainer Rosendahl (ProAgria). Rosendahl was an essential link between local Swedish-speaking farmers and mostly Finnish-speaking research scientists.

The Pedersöre demonstration field (5.8 ha, c. 100 km north of Vaasa) with three plots had been mostly established in the previous year. The area had been under farming within the first half of the 20th century, after which it became forested before it was re-converted into farmland in 2008–2009. The soil was silty and had been oxidized down to c. 2.3 m. Silage was grown by the landowner on the field.

On both fields, a new innovation was applied to prevent the horizontal water flow through soil cracks by installing a vertical plastic sheet along main surface drains. A narrow 1.8-m-deep trench was dug with machinery developed from the common set up for installing subsurface drainage. On both fields, drainage water samples were collected for analyses of nutrients (total N, NO_3^--N, NH_4^+-N, total P, PO_4^{3-}-P, SO_4^{2-}, Cl) temperature, pH, acidity, EC and metals at the same time as the ground water level was measured by ELY Centre. The results of nutrient analyses were put in the prevailing data storage system (HERTTA) where they are available for the public via www.oiva.fi (SYKEs internet server). Water samples were collected ca. 30 and 15 times in Söderfjärden and Pedersöre fields, respectively, during runoff periods in 2010–2012. Water was also sampled from the nearby ditches. Nutrient concentrations were analyzed in laboratory of ELY centre in 2010–2011 and in environmental laboratory owned by the City of Vaasa in 2012. ÅA took care of metal analyses (>20 metals, including Al, Cd, Ni, Zn). The drainage water was very acid (pH 3.8–4.4) and had a very high EC (91–300 mS m^{-1}) and concentrations of sulfate (300–1600 mg l^{-1}), Al (>10 mg l^{-1}), Cd (>2 µg l^{-1}), Ni (> 400 µg l^{-1}) and Co (>150 µg l^{-1}) in Söderfjärden. In nearby ditches the pH was almost the same as in the drainage water from the demonstration fields. In April 2011 samples were also taken from ditchwater of nearby forest and from snow. The pH level was 5.1 and 5.7 in ditchwater from a forested area and in snow, respectively.

In Söderfjärden, greenhouse gases (N_2O, CO_2, and CH_4) were measured and soil was sampled for analyses of nitrogen (NO_3^--N, NH_4^+-N), pH and EC by MTT. Exchangeable or labile macronutrients (Ca, K, Mg, P and S) and micronutrients (Cu, Fe, Zn) as well as Co and Ni were analysed from the plough layer by MTT. Selenium was analysed at Viljavuuspalvelu Ltd, Mikkeli. Total C, N and S concentrations were analysed by the University of Helsinki. The grain yield (given at 15% moisture content) was estimated by harvesting an area of 13–21 m2 in triplicate from each drainage system. The quality of the yield was estimated by determining the test weight (kg hl-1) and 1000-seed weight at MTT. Crop samples (seeds and straw separately) were taken for element analyses (N, P, Ca, K, Mg, S, Fe, Mn, Zn, Cu, Cr, As, Cd, Pb, Co, Mo, Ni) and analysed at MTT. In Pedersöre, actual acidity, potential acidity and sulfur speciation for soil profiles were determined by ÅA and continuous groundwater level measurements were done since July 2010 by the University of Helsinki.

The University of Helsinki measured greenhouse gas (GHG) emissions from 1-m-high acid sulfate soil monolites in controlled experimental conditions in 2010. Emissions were measured biweekly, and additionally two intensive 3-day measurement periods were carried out with heavy rainfall simulation. Simultaneously, pore water was sampled from the topsoil and analysed for dissolved mineral and total nitrogen as well as dissolved organic and inorganic carbon. The lysimeter data forms a reference which can be compared to data from the Söderfjärden demonstration field. The gathered data was used for improving the hydrological model developed for boreal acid sulfate soils (HAPSU). There the impact of controlled drainage on discharge water quality can be simulated using various climate scenarios.

The soil profiles were characterized, analysed and classified by the University of Helsinki according to international WRB system which is endorsed by the International Union of Soil Sciences and by EU. The soils belong to the group Haplic Gleysols (Thionic Humic Dystric Siltic).

Action members participated in the action workshops, and in the demonstrative excursions to the prototype test field in Söderfjärden. The monitoring results were presented i.e. at a workshop in Luleå, Sweden (2.11.2010), at NJF Congress in Uppsala (14–16.6.2011), at two seminars of National Symposium of Soil Sciences in Helsinki (10.–11.1.2011 and 7.–8.1.2013) (Annex 7 and 8), National Congress of Agricultural Sciences in Finland in Helsinki (10.–11.1.2012), at the EUROSOIL 2012 congress in Bari (2.–6.7.2012) and at the 7th International Acid Sulfate Soil Conference in Vaasa (26.8.–1.9.2012).

On the pilot sites, elevated groundwater level via controlled drainage systems and pumping of additional water during dry periods were monitored. Flow peaks were managed and regulated by a controlled subsurface drainage system to find adaptation tools to the changing climate conditions in the Söderfjärden and Pedersöre fields.

Table. 1 Timetable of measurements and samplings in the Söderfjärden and Pedersöre demonstration fields

Place / Sample	Measured Parameters					
	Ground Water Level	Water flow	Nutrients (N and P)	(Heavy) Metals	Temperature and Moisture	pH/Electrical Conductivity
Söderfjärden						
Ground water	Biweekly since end of June 2010 (9 points), and continuously since Oct. 2010 (3 points)					
Water Sampling (3 drainage outlets and nearby ditches)		Continuously since Oct. 2010: 3 points	Biweekly(1) since end of April 2010. Continuously in 1 point since April 2012.	Biweekly(1) since end of April 2010		Biweekly(1) since end of April 2010, Continuously since Oct. 2010: 3 points
Soil Sampling			Twice a year	Spring 2010, 1011, 2012	Continuously since Oct. 2010	Spring and autumn
Plant Sampling			In autumn	In autumn		
Pedersöre						
Ground Water	A few times in spring and autumn, continuously since August 2010					
Water Sampling (3 drainage outlets and nearby ditches)			A few times in spring and autumn since end of April 2010	A few times in spring and autumn since end of April 2010		A few times in spring and autumn
Soil Sampling				April 2010		

Expected results:

1) A manual including technical guidance on how to manage controlling subsurface drainage systems in order to maintain high groundwater levels and reduce leaching of acidity was published both in Finnish and in Swedish (Uusi-Kämppä et al. 2013b,c). A review on methods how to mitigate acid waters was written by ÅA (Österholm 2012) at the same time as the Guidelines for mitigating the adverse effects of acid sulfate soils in Finland until 2020 were submitted.

2) The yields of spring barley and spring wheat were above the Finnish average due to the fertility of the acid sulfate soil. There were no differences in the test weights or in 1000-seed weights between the treatments. During the first three years, the metal concentrations of cereals were within the adequate range and there were no significant differences in concentrations of nutrients or harmful metals in the harvested crops (Tables 2–7).

Table 2. Grain yields in a field experiment in Söderfjärden during 2010 – 2012 (15% moisture content). Values in parenthesis indicate yield variation at three different sampling points.

Drainage method	year 2010 (Barley)	year 2011 (Spring wheat)	year 2012 (Barley)
Conventional drainage	3988 (3376 - 4435)	5740 (5636 – 5857)	5466 (4859 – 5953)
Controlled subsurface drainage	5430 (5196 – 5775)	5861 (5616 – 6060)	5664 (5453 – 6037)
Controlled subsurface drainage with additional pumping of water	4176 (3358 – 4903)	5478 (5152 – 5895)	5349 (5268 – 5409)

Table 3. Concentration of nutrients (g kg-1: P, N, S, Ca, K and Mg; mg kg-1: Cu, Fe, Mn, Zn and Se) in barley grains on a dry weight basis in 2010.

Drainage method	P	N	S	Ca	K	Mg	Cu	Fe	Mn	Zn	Se
Conventional drainage	3.3	19	1.2	0.3	6.3	1.3	4.9	81	12	29	0.1
Controlled subsurface drainage	3.1	19	1.2	0.4	5.9	1.2	5.0	60	14	25	0.1
Controlled subsurface drainage with additional pumping of water	3.6	20	1.4	0.4	6.6	1.3	5.4	64	15	34	0.1

Table 4. Concentration of nutrients (g kg-1: P, N, S, Ca, K and Mg; mg kg-1: Cu, Fe, Mn, Zn and Se) in barley shoots at different development stage on a dry weight basis in 2012.

	Drainage method	P	N	S	Ca	K	Mg	Cu	Fe	Mn	Zn	Se
1st sampling: barley at the leaf development growth stage (BBCH 12)	Conventional drainage	1.9	47	3.8	5.6	39	2.2	8.1	113	16	22	0.8
	Controlled subsurface drainage	3.3	52	3.9	7.3	41	1.9	9.3	139	18	30	1.6
	Controlled subsurface drainage with additional pumping of water	2.2	50	3.7	6.2	36	1.7	8.4	178	16	25	1.5
2nd sampling: barley at the leaf development growth stage (BBCH 14)	Conventional drainage	3.2	44	3.6	5.8	37	2.1	6.7	74	19	28	0.7
	Controlled subsurface drainage	3.9	38	3.3	6.0	38	1.7	6.8	94	28	20	0.5
	Controlled subsurface drainage with additional pumping of water	3.1	44	3.5	6.6	40	1.7	6.8	109	21	24	0.4
3rd sampling: barley at the booting stage (BBCH 47-49)	Conventional drainage	3.2	49	4.9	7.8	30	2.5	7.2	75	24	26	1.1
	Controlled subsurface drainage	3.2	43	4.5	8.0	29	2.0	8.1	92	30	21	1.1
	Controlled subsurface drainage with additional pumping of water	3.6	45	5.1	7.8	32	1.9	8.1	76	25	24	0.7

Table 5. Concentration of heavy metals (µg kg-1) in barley shoots at different development stage on a dry weight basis in 2012.

	Drainage method	Al	Cd	Pb	Co	Cr	Ni	As
1st sampling: barley at the leaf development growth stage (BBCH 12)	Conventional drainage	700	41	97	22	333	223	32
	Controlled subsurface drainage	557	129	77	18	347	244	27
	Controlled subsurface drainage with additional pumping of water	1503	80	151	37	417	761	55
2nd sampling: barley at the leaf development growth stage (BBCH 14)	Conventional drainage	300	43	45	15	427	263	16
	Controlled subsurface drainage	333	108	57	19	397	287	28
	Controlled subsurface drainage with additional pumping of water	717	62	88	24	320	348	32
3rd sampling: barley at the booting stage (BBCH 47-49)	Conventional drainage	190	23	51	15	453	217	< 10
	Controlled subsurface drainage	320	50	56	18	447	242	16
	Controlled subsurface drainage with additional pumping of water	207	27	57	13	430	351	12

Table 6. Concentration of nutrients (g kg-1: P, N, S, Ca, K and Mg; mg kg-1: Cu, Fe, Mn, Zn and Se) in barley grains on a dry weight basis in 2012.

Drainage method	P	N	S	Ca	K	Mg	Cu	Fe	Mn	Zn	Se
Conventional drainage	3.9	16	1.2	0.3	5.8	1.2	3.7	37	8.2	26	0.2
Controlled subsurface drainage	3.9	17	1.1	0.4	5.9	1.1	3.4	50	9.0	22	0.2
Controlled subsurface drainage with additional pumping of water	3.7	16	1.1	0.4	5.9	1.1	3.5	38	8.3	23	0.2

Table 7. Concentration of heavy metals (μg kg-1) in barley grains on a dry weight basis in 2012.

Drainage method	Cd	Pb	Co	Cr	Ni	As
Conventional drainage	25	16	5.7	160	154	11
Controlled subsurface drainage	24	12	6.0	160	150	< 10
Controlled subsurface drainage with additional pumping of water	17	25	6.9	160	135	< 10

3) Recommendations for water management in agricultural acid sulfate soils with different depth of the sulfide layer have been presented in poster presentations in national meetings in January 2012 and in January 2013 (Uusi-Kämppä et al. 2012c, 2013a) and at the 7th IASSC in Vaasa in August 2012 (Österholm et al. 2012).

4) The study carried out in the lysimeters, where water table can be very effectively controlled, clearly shows the increasing trend of pore water pH, substantial decrease of dissolved Al and acidity, some decrease of sulfate, and increase in dissolved Fe in the high groundwater treatment. The respective responses were, as expected, slower in the practical fields but the same trends started to slightly appear in the drainage waters of Söderfjärden (Virtanen et al. 2013). In the lysimeters, the concentration of dissolved iron increased in the case of high groundwater level. In the field, the controlled drainage with pumping of additional water also might have a light effect on increase of iron concentration. Both in the field experiment and in the lysimeters, the level of groundwater did not significantly affect the greenhouse gas emissions. In Söderfjärden, the average flux of nitrous oxide was 79 g N ha-1 day-1 which corresponds to an annual flux of ca. 30 kg ha-1 which is 2–3 times as high as from Finnish organic soils. The emissions of CO2 (daytime total ecosystem respiration in the summer ~500 kg ha-1 day-1) and CH4 (0.6 g ha-1pv-1) were as high as from other Finnish soils. Also in the monolith experiment at Viikki, the N2O emissions from soil to the atmosphere were high from acid sulfate soils but a high groundwater level did not increase the total N2O emissions during monitoring period. Nitrate nitrogen losses in drainage water were also high, 25 kg NO3–-N ha-1 from the field with controlled drainage system with additional water pumping in Söderfjärden during spring runoff. The NO3–-N concentrations in drainage water (20–26 mg l-1) were generally 2-fold compared to the maximum allowed concentration for the household water (Uusi-Kämppä et al. 2013a). In Pedersöre, the NO3–-N concentrations were smaller (< 8 mg l-1) than in Söderfjärden, possibly due to silage using N more efficiently than spring cereals.

5.1.4. Action 4 Socio-economic analysis of adaptation tools

Expected results:

1	An analysis of the economic impacts of different adaptation tools for farm management	
2	An analysis of the economic value of increased fish stocks due to the adaptation tools	
3	A comprehensive overview of the ecological, economic and social impacts of alternative adaptation tools	
4	Shared understanding of the problem, its mitigation measures and their ecological, economic and social consequences among the key stakeholders	
5	Joint recommendations for adopting adaptation tools by Regional Watershed Councils	

The aim of Action 4 was to analyse the socio-economic impacts of adaptation tools and evaluate their social acceptability in the pilot areas. The overall aim was to find cost-effective adaptation strategies that are acceptable among the key stakeholders. This aim was met well. The Action produced an integrated evaluation report (in Finnish, Annex 9) on the socio-economic and also ecological impacts of the alternative adaptation strategies (Table 8 and Figure 1), including a summary table of the economic impacts (Table 9), ecological impacts (Table 10) and social impacts (Table 11).

Table 8. Description of the adaptation strategies.

Alternative 1: Present state
Alternative 2: Controlled drainage • Controlled drainage is expanded to all fields on Kyrönjoen watershed where it is reasonable for preventing acid loads. (i.e. cultivated fields with traditional drainage will be altered to controlled drainage)
Alternative 3: Controlled drainage + plastic sheet + subsurface irrigation • Controlled drainage will be improved with plastic sheet and also with subsurface irrigation where possible (about 30% of subjects have available water less than 100meters away).
Alternative 4: Alternative 3 + restricting drainage on hot spot areas • Cultivated fields with traditional drainage will be altered to controlled drainage like in ALT 3 except in most critical (hot spot) areas, where cultivated species is changed to species that requires more shallow drainage depth (grass, canary-reed). Presumption is that about 10% of field area on AS-soils are hot spot areas where sulfur content is high and sulfur clays are near plough layer (about 1 meter from the surface).
Alternative 5: Alternative 3 + ending drainage on hot spot areas • Cultivated fields with traditional drainage will be altered to controlled drainage like in ALT 3 except in hot spot areas, where drainage will be ended. This will in practise prevent cultication of these fields. Ending of the cultivation will be realised with natural values trading scheme.

Strategy	1	2	3	4	5
Present state	X	X	X	X	X
Controlled drainage		X	X	X	X
Controlled drainage + plastic sheet + subsurface irrigation			X	X	X
Strategy 3 + restricting drainage in hot spot areas				X	
Strategy 3 + ending drainage in hot spot areas					X

Figure 1. The alternative adaptation strategies.

One of the key outcomes of the analysis was that contrary to a starting assumption, adaptation measures that included drainage restrictions in the so called “hot spots” (acid sulfate soils in less than 1.5 meter depth, soil pH under 4.0, and sulfur concentration more than 0.6 %) did not result in significant reduction in acidity in runoff from the fields and consequently in the River Kyrönjoki and River Lapuanjoki. Furthermore, the drainage restrictions and subsequent restrictions in land use and choice of cultivated crops were considered unacceptable among local farmers. Therefore, it seems that extending controlled subsurface drainage in fields with subsurface drainage (Strategy 2) is the most cost-efficient way to reduce acidity in the water bodies. The Strategy 3 with plastic sheet and subsurface irrigation is a good option for farms growing crops that suffer from dryness in the growing season. Also drainage restrictions (Strategy 4 and 5), if implemented through voluntary measures such as nature value trading schemes, could be a feasible option in situations where the fields have a low yield, they are located far away from the farm houses and where the farmers have considered cutting down production in any case. In the “hot spot” areas, the most important measure to reduce the risk from AS soils is to abstain from all new drainage activities, which could increase the runoff from these areas by tenfold.

Action 4 succeeded in engaging the key local stakeholders in the evaluation process and hence carrying out participatory integrated evaluation. We worked closely with two local stakeholder forums called Lapuanjoki Watershed Council and Kyrönjoki Watershed Council, which consist of representatives of local farmers and farmers’ associations, environmental non-governmental organisations, regional environmental and agricultural authorities, municipalities, and fishery. We attended six Lapuanjoki Watershed Council Task Force meetings and two Lapuanjoki Watershed Council meetings, and six Kyrönjoki Watershed Council Task Force meetings and three Kyrönjoki Watershed Council meetings.

Action 4 produced an analysis of the economic impacts of different adaptation tools for farm management (Expected Result 1, Table 2) as well as comprehensive overview of the ecological, economic and social impacts of alternative adaptation tools (Expected Result 3, Tables 2-4, Annex 9).

The analysis did produce an analysis of the current economic value of fish catch both in commercial and recreational fishing but it did not cover the economic value of increased fish stocks due to adaptation measures (Expected Result 2). This was mainly because the economic value of commercial fishing turned out to be quite low (below 50 000 €/year in Kyrönjoki estuary) and it is also difficult to predict the market price of fish in the next ten years. Instead, the Finnish Game and Fisheries Research Centre produced a verbal assessment of the impacts to commercial and recreational fisheries, including the catch of different fish species.

The analysis created a shared understanding of the problem, its mitigation measures and their ecological, economic and social consequences among the key stakeholders (Expected Result 4), but contrary to the optimistic expectations, it did not lead to joint recommendations for adopting adaptation tools by Regional Watershed Councils (Expected Result 5). Farming and fisheries representatives did not contest the results of the analysis but they disagreed on the significance of the costs from the adaptation strategies. From farmers' perspective, the cost to farmers from the adaptation strategies far exceeded the ecological benefits whereas the fisheries representatives maintained that the costs, which occur mostly from labor costs, are not so substantial compared with the improvements in fisheries and ecological quality of Kyrönjoki and Lapuanjoki rivers. However, the discussion about future action will be continued in both Watershed Councils. The results were available only towards the end of the project and hence there was only one meeting in each Watershed Council Task Force to discuss the conclusions that can be drawn from the analysis. The final results will be presented in both Watershed Council meetings in spring 2013 which will provide a further opportunity to draw joint conclusions from the evaluation.

MTT Agrifood Research Finland (MTT) carried out the assessment of economic impacts of different adaptation tools for farm management by using linear programming and calculating the investment and labor costs from different strategies, taking into account 3 % discount rate.

SYKE was in charge of producing the comprehensive overview of the ecological, economic and social impacts of alternative adaptation tools by using multi-criteria analysis and value tree approach, which structures the problem (Figure x). SYKE was also responsible for engaging the actors in the two Watershed Councils in the work to create a shared understanding of the problem and to facilitate a joint problem solving. The discussions in the Watershed Councils also served as a basis for the social impact assessment. Furthermore, at the request of the Watershed Council members, SYKE also carried out 12 face-to-face interviews with local farmers and fishermen in the region.

The Finnish Game and Fisheries Research Centre was in charge of the impact assessment concerning fisheries. The assessment was based on a fish catch data base in outlet rivers of Gulf of Finland as well as the predictions of chemical status of the River Kyrönjoki as a consequence of the adaptation strategies. SYKE Laboratory Centre provided these predictions.

Åbo Academi produced the estimate of reductions in SO4 loading in the alternative adaptation strategies, based on the results in Action 3. This served as a basis for the predictions of chemical and ecological status of River Kyrönjoki by SYKE Laboratory Centre.

The aim of Action 4 was also to analyse the adaptation strategies with respect to the relevant climate change scenarios and associated projections on impacts derived from Action 2.

Table 9. The economic impacts from the alternative adaptation strategies.

Evaluation criteria	Strategy 1	Strategy 2	Strategy 3	Strategy 4	Strategy 5
Yearly additional cost to farmers per hectare, €/ha/v	0	124	171	154[1]	139[2]
Yearly additional total cost to farmers, M€/v	0	2,73	3,76	3,39[1]	3,06[2]
Yearly additional cost to Finnish Government per hectare, €/ha/v	0	65	82	64[1]	32[2]
Yearly additional total cost to Finnish Government, M€/v	0	1,43	1,81	1,41[1]	0,69[2]
Impacts to commercial fishery, €	The average value of catch in years 2000-2009 was 50 000 €	No increase in commercial fishing. Some signs of increase in the value of catch. For instance, the catch of burbot might increase.	Like in strategy 2.	Some increase in commercial fishing. The catch of valuable species such as burbot, white fish and pike perch will increase.	Like in strategy 4.
Impacts to recreational fishery, €	The commercial value of the catch in recreational fishing[3] was around 100 000 € in year 2009	Some increase in the value of the catch. For instance, the catch of burbot might increase.	Like in strategy 2.	The catch of valuable species such as burbot, white fish and pike perch will increase.	Like in strategy 4
Impacts on regional economy		No impacts	No impacts	No impacts	Some impacts when the cultivated area will be smaller, leading to multiplicative effects in regional economy

[1] Assuming that there are no changes to the agricultural subsidies.
[2] Costs in a situation where there are no agricultural subsidies for so called hot spot areas but the costs from giving up from cultivation are compensated through e.g. nature value trading scheme.
[3] This does not include people's willingness to pay for fishing as a recreational activity, only the economic value of the catch

Table 10. The ecological impacts from the alternative adaptation strategies.

Evaluation criteria	Strategy 1	Strategy 2	Strategy 3	Strategy 4	Strategy 5
Spring time observations in which the pH value is likely be under the critical threshold (pH 5.5) , %	In 26 % of the days in April-May the pH value is below 5.5.	In 15 % of the days in April-May the pH value is below 5.5.	In 12 % of the days in April-May the pH value is below 5.5.	In 12 % of the days in April-May the pH value is below 5.5.	In 11 % of the days in April-May the pH value is below 5.5.
Autumn time observations in which the pH value is likely be under the critical threshold (pH 5.5) , %	In 32 % of the days in the autumn the pH value is below 5.5.	In 16 % of the days in the autumn the pH value is below 5.5.	In 16 % of the days in the autumn the pH value is below 5.5.	In 15 % of the days in the autumn the pH value is below 5.5.	In 15 % of the days in the autumn the pH value is below 5.5.
pH-value	The average pH value is currently 5,7 in River Kyrönjoki . The lowest values are 4,5 - 5,0, and at times even under 4,5.	The average pH value will be close to 5,9. The likelihood of pH values under 4,5 is very small.	The average pH value will be close to 5,9. The likelihood of pH values under 4,5 is very small.	The average pH value will be close to 5,9. The likelihood of pH values under 4,5 is very small.	The average pH value will be close to 6,0. The likelihood of pH values under 5,0 is very small.
Metals	Because of acidity, the metal load to rivers is considerable, including Al, Mn, Cd, Zn and Ni	Cd, Zn, Al, Ni and Mn concentrations in river water will decrease by 13 %.	Cd, Zn, Al, Ni and Mn concentrations in river water will decrease by 14 %.	Cd, Zn, Al, Ni and Mn concentrations in river water will decrease by 16 %.	Cd, Zn, Al, Ni and Mn concentrations in river water will decrease by 17 %.
Change in the fish stock	The current fish stock. Fish deaths are likely to take place every two to three years.	The stocks of sensitive species such as burbot and bullhead will grow stronger.	The stocks of sensitive species will grow further stronger.	The stocks of sensitive species will grow further stronger.	The stocks of sensitive species will grow further stronger.
The ecological status of water bodies	The ecological status of River Kyrönjoki is currently passable or bad.	The recovery of the river will begin. From bad to passable?	The recovery of the river will begin. From bad to passable and from passable to satisfactory?	The recovery of the river will begin. From bad to passable and from passable to satisfactory?	The recovery of the river will begin. From bad to passable and from passable to satisfactory?

Table 11. The social impacts from the alternative adaptation strategies.

Evaluation criteria	Strategy 1	Strategy 2	Strategy 3	Strategy 4	Strategy 5
Farming practices	No changes in farming practices.	Investment cost for producers. Some increase in the amount of labor. Decrease in the use of fertilizers and the subsurface drainage system will stay cleaner..	Investment costs are bigger than in Strategy 2. The technique is new and hence producers take a bigger risk. The harvests can be bigger, especially in dry years.	Negative impacts on production and continuity of the livelihood. Increased control from outside (restrictions in the choice of crops)	Negative impacts on production and continuity of the livelihood. Voluntary nature trading scheme for AS soils can be a good option for some farmers.
Commercial and recreational fishing	Pike, perch, bream, and roach are the most important specie. Occasional fish deaths. Fisherment have to travel far in order to fish.	Some improvement both in commercial and recreational fishing. The catch of current species will be better and the stocks of burbot will increase.	Like Strategy 2.	Some improvement both in commercial and recreational fishing. The catch of current species will be better and the stocks of burbot and also pike perch will increase.	Like in Strategy 4. The planting of fish will be more successful and hence there will be more planted valuable species such as trout.
The clarity of water as an aesthetic factor	the acidity can control algae blooms	Possible minor increase in alga blooms.	Possible minor increase in alga blooms.	Possible minor increase in alga blooms.	Possible minor increase in alga blooms.
Cultural landscape	Large open fields are an important feature of regional cultural landscape	no impact	no impact	no impact	Changes in the cultural landscape due to giving up cultivation of some fields.

5.2. Evaluation of results.

The method of raised groundwater level in controlled drainage system with pumping of additional water and installation of plastic sheet into soil to keep the added water in field is possible on fields of level topography (gradient < 2%). Method is cheap if the controlled drainage system already exists on the field. A groundwater pipe with floating groundwater antenna in the middle of each field is needed. The antenna will rise and sink with corresponding changes in the groundwater level and help the farmer to set an appropriate level of outflow. The cost of plastic sheet and its installation with an underdraining machine was about c. 5 euro per meter. Two men were needed to install c. 400 m of plastic sheet in one day. Additional water e.g. from a nearby ditch, river, pond or watershed was needed. The pumping of additional water cost annually c. 95–195 euro per hectare according to count of pumping. We point out that the amount of water needed to keep the sulfidic soil layers submerged was no more than 25–50 mm. The price of one regulation well (including planning, material, groundwater pipe and work on the field) is c 1000–1200 euro (VAT 0%).

Other method is liming where alkaline material is added to soil or receiving waters. Liming of soil keeps the acid sulphate soils fertile and suitable for grain growing. It doesn't, however, stop discharge of acidity and leaching of metals from deeper layers (the real origin of acidity) which are oxidized. Although crops grow well after liming, the environment may be acidified. The liming of surface water may be successful in some circumstances. However, in the study area, the theoretical annual lime requirement (conventional agricultural lime of which c. 50% dissolves in water) would be over 600 kg/ha and over 1400 ton for the whole Söderfjärden area. Without considering labour costs and equipment needed, the costs for liming with the most affordable agricultural lime (50–55 €/ton) would be in the order of 30 €/ha/a and 80000 €/a for the whole area. It is also notable that with such heavy doses in this metal rich water, the fraction of the lime not dissolving in the water may be much higher than expected and large amounts of metal precipitates would accumulate in the drains. Consequently, liming of water courses is probably not a realistic option in these areas. Soil surface liming is not an option either because the applied lime does not penetrate below the organic topsoil, i.e. it does not reach the acid sulfate soil horizons. To overcome this problem, there is a 4-year project (PRECIKEM), which basically utilizes similar techniques as those in CATERMASS, but where calcium carbonate suspensions ($CaCO_3$) are injected through drainage pipes into the environmentally critical subsoil. According Stén et al (2012) at 7th IASSC in Vaasa the injection of $CaCO_3$ is not considered merely as a neutralizing agent but, more importantly, as an oxidation-inhibiting chemical de-activating the acidophilic bacteria that mediate pyrite oxidation. Results from the first year of operation are promising but the long term effects are unknown.

The other demonstration field originally planned in Ylistaro was replaced with the Pedersöre field being mostly established before the project in the previous autumn. The Pedersöre field with three plots was found more appropriate due to better stakeholder engagement (owned by a private farmer while Ylistaro field would have been situated at the former MTT Research Station).

There were some problems to keep the water level high enough in the plot with controlled drainage and additional water pumping during summer 2011, since the pumping were done twice and altogether 25 mm water was pumped. Summer 2012 was quite rainy and the pumping of 4 times (c. 48 mm) helped to keep the sulfide layer under groundwater level. In other treatments, part of the sulfide layer was over groundwater level during dry summer months. We believe that controlled drainage systems with pumping of additional water and isolation plastic sheet helped to restrain leakage of subsurface water in the Söderfjärden field.

The effects of high groundwater level are slow in soils and therefore the monitoring programme should be continued on the demonstration fields. Low soil temperature in the subsoil (5–10 °C) contributes to slow microbial reactions, which, in turn, are prerequisites of increasing pH of the acidified soil. There is a lag in the improvement of the water quality upon elevated groundwater table also because it takes probably several years to leach out the oxidation products already present in the soil at the beginning of the monitoring period. Therefore it was very useful to have a comparable lysimeter experiment where the treatments could be applied more vigorously. The lysimeter study probably indicates the outcome in the field in a long run. Technically, the acid environment is a challenge for the measuring equipments and their function.

There was no evidence that controlled drainage decreases runoff. In Söderfjärden field, the subdrainage flow was slightly greater from controlled drainage system (320 mm) than from conventional drainage (280 mm) in year 2012. The flow was 300 mm from controlled drainage with additional water pumping. In addition to that it is also a challenge to evaluate water balance from the field which is flooded in spring.

The project and its results have been presented in national meetings and seminars as well as international congresses.

Applications for funding are on their way to enable monitoring of the quality of drainage water and greenhouse gas emissions on both of the demonstration fields (Söderfjärden and Pedersöre). At least in Söderfjärden, measurements can be continued for 18 months with current funding from the Ministry of Agriculture and Forestry, and some foundations (e.g. Maa- ja vesitekniikan tuki, Jokirahastot and Salaojituksen tutkimusyhdistys).

According the preliminary results discharge of acidity and leaching of metals in field runoff can be mitigated from acid sulfate soils by raising the groundwater level. Pumping of additional water into controlled drainage systems and installation of plastic film into the lower edge of the field enhance the effects.

A new method was developed to keep the additional water in the field – the installation of plastic sheet extending to sulfide layer in the lower end of the field –> Cost-effectiveness of the practices are much higher.

5.3. Dissemination issues

Expected result:

Availability and accessibility of the products and experiences of the project to all interested users	
utilisation of the results by the project partners and other interested institutions	

Oral presentations, posters, publications and other dissemination outputs are presented in Annex 10.

List of Dissemination activities in chronological order:

- Press release published 15th January about starting of the CATERMASS project describing problems of the AS- soils and the main tasks of the project. Press release went through well and evokes several articles on newspapers.
- Press release published 10th February about CATERMASS kick-off meeting and seminar as invitation to local media. Press release evokes 1 article about CATERMASS project.
- Public project seminar was arranged on 10th February with 85 registered participants from municipalities, stakeholder organizations (farmers,) Land use planners, environment administration (Annex 4 in Interception report 28.09.2010)
- Project website launched 29th march. www.ymparisto.fi/syke/catermass
- Project brochure was published on April 2010 first in Swedish and later in June in Finnish and English (Annex 5 in Interception report 28.09.2010).
- Press release published on 14th April about CATERMASS project and public meeting for stakeholders (local farmers) in Sundom, Korsholm.
- Public meeting was arranged on 13th April for stakeholders in Sundom, Korsholm with 38 participants. CATERMASS project, Problems of AS-soils and Söderfjärden testsite were presented to stakeholders.
- Article in Maaseudun tiede 31.5.2010 (Annex 11)
- Press release published on 3.6.2010 about acidity of river waters on spring 2010.
- Stakeholders (ProAgria and ÖSP) and partners jointly presented the project and pilot area 21st June during the visit of the Permanent Secretary Hannele Pokka from the Ministry of Environment, Finland.
- Press release published on 23.9.2010 about seminar 5.10 as invitation to local media..
- Seminar for the stakeholders and the project meeting was arranged on 5.–6. October 2010 in Stundars, Korsholm with the field excursion to the demonstration field at the Söderfjärden.
- Catermass project was presented at Luleå, Sweden in Swedish-Finnish seminar on Acid sulphate soils and land use at 1.–2. November 2010. Presentations and program of the meeting can be found in: http://www.vattenmyndigheten.se/Sv/bottenviken/deltagande-och-

dialog/seminarier-och-konferenser/sulfidjordar-och-markanvandning/Pages/default.aspx

- Public meeting was arranged on 15. November 2010 for stakeholders in Pedersöre. CATERMASS project, Problems of AS-soils and Pedersöre test site were presented to stakeholders.
- Press release published on 7.12.2010 about acidity of river waters on autumn 2010.
- Web pages (www.catermass.fi) for information on AS-soils and methods mitigating harmful ecological effect were opened 1st March 2011.
- Project logo was designed and will be used on web site, presentations and other material. Project notice boards at the demonstration sites were updated and web-pages (www.catermass.fi) were updated regularly. Also business card sized handout containing brief facts and contact information to the project web sites was produced for the use of field groups. Small number of caps with Catermass- logo was produced to be given out to land owners of the demonstration site and to other stakeholders.
- Press release published on 3.6.2011 about acidity of river waters on spring 2011.
- Progress in CATERMASS project has been presented to stakeholders at several Negotiation Group and Working Group meetings of different River Basins:
    - Negotiation Group for River Ähtävänjoki, Purmonjoki, Kruunupyynjoki & Kovjoki May 2011
    - Working group for River Kyrönjoki June 2011 and Febryary 2012
    - Negotiation Gruop for River Kyrönjoki September 2011
    - Working group for River Lapuanjoki January 2012 and April 2012

- Demonstration of prototype fields and CATERMASS project to National network for drainage June 2011
- Press release published on 22.6.2011 about second field season of the CATERMASS project.
- Presentation of project at Farmari 2011 –exhibition for Finnish farmers July 2011
- Newspaper article in Landsbygdens folk 29.7.2011 (annex 10 in Progress Demonstration of prototype fields and CATERMASS project to Swedish group from Federation of Swedish Farmers Norrbotten/Västerbotten October 2011
- Demonstration of prototype fields and CATERMASS project on Information and demonstration event for Best Practises 25.10.2011
- Press release published on 26.10.2011 about demonstration event for Best Practises
- Newsletter distributed for all River negotiation groups, for all members in Co-operation group for water management and for environmental secretars in municipalities. December 2011
- Press release published on 27.12.2011 about acidity of river waters on autumn 2011.

- One page profile of Catermass project was published in Magazine Public service Review: European Union: Issue 23 (annex 13 in Progress Report 30.10.2012)
- Article in VAKO 1-2012 (Annex 10)
- Presentation and discussion at schooling day for Agricultural offices in South Ostrobothnia January 2012
- Press-release 22.3.2012 about results from demonstration field season 2011
- Project presented at SLC´s (The central union of Swedish-speaking agricultural producers in Finland) summer conference 27-28.6.2012 (~200 participants)
- Presentation of the project and test-fields to visitors from Northern Ostrobotnia ELY-centre 28.9.2012 (~29 people)
- Report 30.10.2012)
- Planning of co-operation with ProAgria South Ostrobothnia January 2012
- An articel about applying farmings subsidies for controlled drainage in Acid Sulfate Soils
- Radio article in Radio Vega Österbotten 23.3.2012
- Planning the field-season together with the farmers 2012
- Article in LF 18.5.2012 (annex 11 in Progress Report 30.10.2012)
- Press release published on 3.7.2012 about acidity of river waters on spring 2012.
- Participation to organization of a field day 28.8.2012 at Söderfjärden test fields for 7IASSC-conference in August 2012 Vaasa (~100 people)
- Post-conference field trip around Southern Ostrobotnia and test field in Pedersöre 31.8.- 1.9.2012 (~50 people)
- Poster presentations at the 7IASSC-conference (~110 participants)
- Public session and poster presentations during the 7IASSC-conference 29.8.2012 (~110+50 participants)
- Articles about Conference and project in Vasabladet 28.8.2012 (annex 12); Pohjalainen 29.8.2012; Landsbygdens folk 31.8. & 7.9.2012
- Participation to the information and demonstration event organized by ProAgria Etelä-Pohjanmaa (~25 people) at Rintala area in Seinäjoki 4.10.2012
- Press release published on 11.12.2012 about public seminar of results of Söderfjärden prototype field
- Public meeting was arranged 11.12.2012 at Stundars to present results of prototype field.
- Press release published on 20.12.2012 about acidity of river waters on autumn 2012

5.3.1. Layman's report

CATERMASS Layman’s report (English version) is presented as annex 13
Document is also available in Finnish and Swedish.

5.3.2. After-LIFE Communication plan

CATERMASS After-LIFE Communication Plan is presented as annex 14

6. Comments on the financial report

6.1. Costs incurred

PROJECT COSTS INCURRED				
	Cost category	Total cost according to the Commission's decision*	Costs incurred from the start date to 31/12/2012	%**
1.	Personnel	2116136	2175694	103 %
2.	Travel	216100	165242	76 %
3.	Outside assistance	184760	199274	108 %
4.	Durables: total non-depreciated cost	120200	134535	12 %
	- Infrastructure sub-tot.			
	- Equipment sub-tot.	20200		0%
	- Prototypes sub-tot.	100000	**134535**	**135 %**
5.	Consumables	15725	**50118**	**319 %**
6.	Other costs	1500	911	61 %
7.	Overheads	185102	189992	103 %
	SUM TOTAL	2839523	2915765	103 %

Personnel costs (category 1) incurred from project start are 59558 € higher than approved budget. Cost overrun of that category is still under limit of 10%.

Travel and subsistence costs (category 2) has been over estimated in original budget but that helps to balance the budget for those cost categories where original budget was under estimated. Main reason for over estimation was effective use of public transport on traveling and the well working video conference equipment at the partner organizations which made traveling to meetings unnecessary.

Cost overrun in category 3 (outside assistance) was 14514 €, still within the limits of 30000 € or 10.

Prototype costs (category 4) were budgeted to be 100000€. Costs were 34535€ (35%) higher than budgeted. Cost overrun exceeds the limits 30000€ and 10%. Separate clarification of reasons for that is presented as annex 15.

Cost overrun in categories 5 (Consumables) is clear. Costs are 34393€ (219%) over budgeted and exceeds the limit of 30 000 € and 10%. That is mostly because devices and equipment budgeted for equipment cost category were not such kind of equipment (so expensive) that they could have been put in this category. Expenses of those devices are reported in consumables category.

6.2. Accounting system

Commission model time sheets or other document containing the same information are used to follow work hours. Timesheets used to report the work done for the project differ by partners. Some partners use the timesheet obtained from the LIFE+ web site and others use electronic time registration system and print out monthly reports.

Coordinating beneficiary and other beneficiaries use separate cost accounts for the project. The use of the financial reporting documents for LIFE+ projects (LIFE+ TES) were instructed for financial officers of all beneficiaries. The suppliers of services, equipment or consumables are being asked to include project acronym or project name with the reference number to the invoices. Project manager of each partner approves the costs. The travel and subsistence cost follow up system follows the national guidelines and national method for selection of sub-contractors is applied. National rules of depreciation are followed.

6.3. Partnership arrangements (if relevant)

After receiving the first pre-financing payment and Mid-term prefinancing payment coordinating beneficiary transferred payments to partners according per cent share of each partner of the approved EU contribution of project budget.

Each partner enter the information to Life+ TES-sheets and financial officer of the coordinating beneficiary combines the information to single Life+TES-sheet for the financial report.

6.4. Auditor's report/declaration

An independent financial auditor nominated by coordinating beneficiary has verified final statement of expenditure and income to be provided to the Commission. Auditors report is attached as annex 16.

7. Annexes

7.1. Administrative annexes

Partnership agreement has been signed in seven copies by all beneficiaries (EPO-ELY: 23.04.2010, GTK: 27.04.2010, MTT: 27.04.2010, RKTL: 05.05.2010, HY: 26.04.2010, ÅA: 03.05.2010, SYKE: 22.04.2010). It has been submitted to the Commission with the Interception Report (28.09.2010).

7.2. Technical annexes

Annex 1 A map showing the areas where AS-soil mapping has been done

Annex 2 Guidance leaflet of AS-soils in Finnish

Annex 3 A preliminary interpretation map

Annex 4 "Site card" from the database showing data of site.

Annex 5 A report document on water quality monitoring

Annex 6 Poster presented in the International Acid Sulfate Soil Conference at Vaasa, Finland (August 29th 2012)

Annex 7 Poster abstract

Annex 8 Poster abstract

Annex 9 Report on Socio-economic analysis of adaptation tools

Annex 17 List of keywords and abbreviations used

7.3. Dissemination annexes

Annex 10 Dissemination outputs of Actions 1-4

Annex 11 Article on Maaseudun tiede 31.5.2010

Annex 12 Article on VAKO 1/2012

Annex 13 CATERMASS Layman's Report

Annex 14 Catermass After-LIFE Communication Plan

7.4. Financial annexes

Annex 15 Report on procurement method of Weather stations

Annex 16 Auditors Report

7.5. Final indicators tables

Annex 18 Final indicators tables

Financial report