SCARP

Mid term report

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Introduction

The six year Swedish Clean Air Research Programme SCARP started 1 November 2006 as a national programme for further coordination and scientific research to further develop science in support of air pollution policies. The programme was divided into two phases with a mid term review. This report is the main input to that review.

Background

SCARP was established with the understanding that, even if the air pollution situation had improved substantially since 1990 and the CAFE strategy (published in 2005) outlined further improvements up to 2020, there would still be a need for further improvement in air quality to protect human health and ecosystems in Europe and Sweden. The proposal was also directed towards areas, where large uncertainties in our understanding still exist:

- Causes and mechanisms for air pollution effects to humans.
- Formation and dynamics of aerosols in the atmosphere and how to include these processes in atmospheric models
- Dynamics and effects of nitrogen deposited to terrestrial ecosystems,
- Strategies for abatement measures, in particular on the national level.

The research areas are described in detail in the original program plan from 2006.

SCARP was established as a continuation of two earlier research programs: SNAP , with the aim to contribute with new information that can be used for quantitative risk assessment regarding air pollution and ASTA, with the primary aim to, by scientific research, support international measures to control transboundary air pollution in Europe.

Due to the limited budget and the ambitious activity plan of the program, the program had to a large extent rely on support from other sources. Most of this support has been through research grants achieved from both national and international organisations. Details on this support is given in Table x.

Achievements during phase 1.

In this section, we describe the overall achievements during phase 1 and also outlines the directions for phase 2. Details on single projects are given in Appendix 1.

The program has in general followed the outlined plan and there have been substantial progress in all projects. Within a couple of projects, there have been minor delays, mainly depending on factors outside the program such as problems with additional funding or delays in delivering data necessary for the outlined research activities.

For the sub programme 4, Integrated Assessments, there have been some revisions in the directions of research. These were initiated by the Swedish Environmental Protection Agency.

The scientific output is large, in total xx scientific publications. Even if many of the publications also results from cofounded activities, the outputs is fairly large given the limited overall programme budget.

The research and publications will give significant contributions both to our scientific understanding and to policy development. Recent SCARP achievements include results on:

- Air pollution effects to children

- Air pollution effects to particular sensitive groups (asthmatic and cardiovascular deceases)
- Real exposure effects of ozone and PM
- Effects on the cardiovascular system from direct exposure of diesel exhaust and ozone
- Implementation of an aerosol module into the MATCH and EMEP models
- Establishment of a European database on PM emissions including organic and elemental carbon
- Risk estimates for N leaching in Swedish forests
- A new concept for critical loads for N
- A Swedish module of the GAINS model
- A Swedish energy projection baseline calibrated for the GAINS model
- A database on fuel efficiency improving measures to be included in the GAINS model

Area 1 Exposure and health effects

Area coordinator: Göran Pershagen, KI

Objective: To assess health effects related to short- and long term exposure to ambient air pollution relevant to the situation in the Nordic countries. Particular emphasis is on determination and quantification of effects associated with exposure to particles from different sources, such as road traffic and wood burning locally as well as long range transport.

Participating organisations The principle researchers in the area of particulate and health are: Anna-Carin Olin and Gerd Sällsten from Göteborg University, Tom Bellander and Göran Pershagen from Karolinska Institutet as well as Bertil Forsberg and Thomas Sandström from Umeå University.

Results Phase 1: The activities in the health area during Phase 1 have been organised in 12 subprojects. These subprojects have often involved contributions from several research groups, also groups primarily contributing to the particulate modelling area of SCARP. It should be realised that the support from SCARP generally accounts for only a minority of the funding necessary to conduct the costly epidemiological and experimental projects in the health area.

Adverse effects by traffic related air pollution have been documented in 4 year-old children in relation to asthma symptoms, pollen allergy and lung function disturbances. Analyses are ongoing for the children up to 8 years of age. Addresses for homes, daycare and schools up to age 8 have been retrieved, revised and geocoded. Dispersion modelling has been performed. This project is a good example of cross-fertilisation between health and air pollution groups within SCARP. Co-operation with the Department of occupational and environmental health, Stockholm county council; SLB-analysis, Stockholm municipality.

With regard to short term effects by air pollution a study of patients with cardioverter defibrillators (ALVA) has been concluded and a report has been published indicating adverse effects by traffic related air pollution. The substudy of inflammatory markers (AIRGENE) has been concluded and has resulted in several publications showing effects by ambient air pollution.

Two 10-week panel studies have been conducted in Umeå focusing on road dust PM and ozone in spring and two panel studies focusing on wintertime PM in Lycksele, where wood burning for house heating is common. In both settings one panel was an asthma panel and one was a panel of highly exposed outdoor workers. Analyses of effects on exhaled NO have been performed and will be presented at the ERS Congress in Berlin in October 2009. This project will increase our understanding of the respiratory effects of different types air pollution, especially the effects of road dust, which are very policy relevant in Sweden.

The association between motor-vehicle exhaust and asthma incidence in adults from the three Swedish cities has been studied in a cohort from the first 9 years of follow up. The first ever paper in the international literature on adult onset asthma and NOx level outside the home was recently published and included in a doctoral thesis. One paper on asthma and PMexhaust is under preparation. This project is quite unique in its analyses of long-term exposure to traffic pollution and development of chronic respiratory morbidity in adults. The traffic related asthma incidence in adults will likely be an important part in future analyses of health costs.

A basic clinical examination has been performed in 6600 individuals with NO in exhaled air, spirometry, blood tests for inflammation markers in blood and genetic analysis, and a series of questionnaires. Data for the 2200 first investigated individuals showed that NO formation in the peripheral airways is increased by increased ozone concentrations in outdoor air, measured at central measuring station, if one takes into account the cumulative exposure 3, 12 hours and 5 days before the examination. We also saw a smaller increase in NO levels after exposure to high particulate levels (PM10). We found, however, no effect of exposure to air pollution in biomarkers reflecting the central airways. A manuscript will be sent in August 2009, and the results will be presented at two international conferences 2009.

In addition to what was described in the initial program, a follow-up study has been initiated. All participants receive 4 years after the initial study a mailed questionnaire, including on emerging respiratory problems. So far, 3700 individuals received the form and around 90% have responded. In this dataset, which will be expanded until all subjects are included, the incidence of respiratory symptoms will be analyzed in relation to chronic exposure to air pollution and including potential genetic susceptibility.

With the aim to investigate whether exposure to different types of air pollution increase the risk for myocardial infarction 650 consecutive patients who fell ill with acute myocardial infarction or acute angina pectoris during the period 2001-2003 in the Gothenburg region have been examined as well as 3600 controls. Acute exposure to PM10, PM2, NOx and ozone days before the infarction/event has been modeled for each individual on the basis of residence.

One project has the aim to assess the relation between long-term exposure to ambient air pollution and total public health burden, primarily involving effects on cardiovascular and respiratory morbidity and mortality. A cohort has been established in Stockholm county including about 25 000 subjects from four subcohorts with detailed information on risk factors and outcomes. An extensive air pollution measurement program supported by the EU is ongoing to validate the exposure assessment methodology. A residential history from 1991 will be obtained from all study subjects as a basis for the exposure assessment, involving some 50 000 addresses.

Another project aim to study interactions between traffic related air pollution and genetic susceptibility in relation to myocardial infarction. A manuscript is in press indicating that long-term exposure to ambient air pollution increases the levels of some markers of systemic inflammation (IL-6, CRP). The analysis was based on the control subjects in the SHEEP study, which are also included in the gene-environment interaction analyses. Another manuscript is under preparation on interactions between genetic variants (polymorphisms) in genes involved in inflammation or coagulation and ambient air pollution in relation to the risk of myocardial infarction.

Several papers have been published showing how ozone and diesel exhaust interacts with the lungs, leading to events in the cardiovascular system that are linked to the increased health effects related to these pollutants. These studies involve controlled ozone and diesel exhaust chamber exposures and sampling and measurements of cardiovascular and respiratory effects in human research subjects, including patients with COPD and cardiovascular disease. The focus is on mechanisms behind the adverse cardiovascular and respiratory effects by diesel exhaust.

Another project aims to increase the understanding of how source, size and chemical characteristics of particulate matter pollution contributes to adverse cellular and biomedical events, linked to adverse health effects. Collection of air pollution PM and physical and chemical characterisation together with toxicological analyses are under way. Air pollution particle sampling and characterisation regarding physical and chemical properties has been performed as well as analyses of biomedical mechanisms behind health effects in bronchial mucosal biopsy samples and in-vitro systems.

One project aims to find out whether effects of wood smoke on airway inflammation and blood coagulation found in a recently performed study can be repeated at lower levels of particles and if the effects differ in relation to the fraction of ultrafines (UFP < 100 nm) in the smoke. Two articles related to this project have been published and another one has been submitted. The project is well integrated in the SCARP programme for example by collaboration with Thomas Sandström's group in Umeå. The issue of wood smoke is important for policy makers.

Another project aims is to test if the risk of myocardial infarction (MI) in Gothenburg increases on days when the origin of the air mass is from certain specific areas in Europe. It is still unclear which properties of PM are significant for toxicity. The role of the origin of the air masses is unknown. The original investigation has been modified to study the effect of air pollutants from both local and distant sources on the risk of myocardial infarction among Swedish men and women in a case-crossover study.

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Area 2 Regional and national atmospheric models for particulate matter

Area coordinator: HC Hansson, ITM, Stockholms Universitet

Objective: Develop and validate modes for particulate matter (PM), from urban to regional scales for the assessment of effects to human health and climate.

Participating institutions: Stockholm University (HC Hansson, Peter Tunved, Christer Johansson), Swedish Meteorological and Hydrological Institute (Joakim Langner, Lars Gidhagen, Cecilia Bennet), Lund Institute of Technology (Erik Swietlicki), Chalmers / Gothenburg University (Mattias Hallqvist) and Norwegian Institute of Meteorology / EMEP (David Simpson).

Sub-projects

The overall aim of the urban and regional scale modelling work is to develop evaluated modules dealing with both dynamics and chemistry, which can be applied in 3-D models for the prediction of health-related PM data. As a basis for this, we make use of a comprehensive "reference" modelling system against which to develop and evaluate computationally efficient models, which can be used in 3-D models. The reference scheme is based upon existing models from the University of Helsinki group, and further developed to include extended chemical and cloud schemes by ITM, Stockholm University. The same reference model is used in sub-projects (1) and (2), with a focus on chemistry in sub-project (1) and on dynamics in sub-project (2). These two sub-projects are interacting continuously, with frequent exchange of routines in order to merge the chemical and dynamical methodologies into one module.

1/ Further develop and validate a model describing the chemistry of aerosols, with a focus on the organic fraction of PM.

The final description should be able to use for the calculation of the organic mass fraction in 3D Eulerian models. The work focuses on development of chemical schemes, to be applied within

MATCH and EMEP. Evaluation are done against the comprehensive reference model and against measurements, e.g. those of the EMEP EC/OC campaign, EU CARBOSOL project, MISTRA-project on organic aerosols co-ordinated by GU and MET.NO and the FP6-infrastructure project EUSAAR, which coordinate measurements at 20 super sites in Europe. Additional measurements of 14C to determine the fractionation between fossil and recent carbon might be added. SU and LTH are partners in EUSAAR.

2/ Develop descriptions of dynamic particle processes.
The aim is to describe how the emissions influence the number, mass and chemistry of the atmospheric particles with high spatial and temporal resolution. The work is conducted in close co-operation with sub-project (1) with the specific objective to develop and evaluate a computationally fast aerosol dynamics module, capable of simulating the aerosol size distribution and composition in the framework of 3D Eulerian models (MATCH and EMEP) on local to regional scale. Detailed process descriptions are already evaluated in Lagrangian studies, which will be used in the evaluation of suitable parameterizations that can be implemented in the 3D models. The work focuses on tracking the number, mass and composition of particles simultaneously. The main processes involved in aerosol dynamics are nucleation, condensation/evaporation, coagulation, deposition and cloud interactions. The above processes are validated against the reference modelling system (outlined above) and the available size resolved and chemically resolved aerosol data (same as in sub-project 1).

3/ Construct emission databases for dynamic particle models and validate urban models concerning particle size distribution and chemistry.
The aim is to develop source specific particle-size resolved emission factors for both number and mass. The emission factors are implemented in an emission database suitable for both urban and regional particle dynamic models that should describe how the particle-size distribution develop and disperse over an urban area. The importance of aerosol dynamic processes for urban scale modelling will also be evaluated and the dispersion model calculations will be validated by comparison with observations.

Summary of accomplished work within Phase I
Considerable effort has been put into further develop the descriptions of the organic chemistry. However our research, which is consistent with others, has shown that the knowledge on the atmospheric organic chemistry is still not sufficient to establish well founded model descriptions. The work has thus been focused on developing, implementing and testing simple organic models. Aerosol dynamic modules for implementation into the regional atmospheric models, MATCH and EMEP, have been evaluated. SALSA, developed by University of Helsinki and University of Kuopio, was chosen and has been implemented into MATCH, and is currently tested.
The reference model, SU-UHMA, a detailed box model based on the aerosol dynamic model UHMA developed by University of Helsinki, has been further developed including detailed chemistry and a simplified cloud interaction scheme, that has been tested.
A European emission database has been accomplished in close cooperation within the EU-integrate project EUCAARI. Our contribution has been emission estimates on wood combustion and road traffic. The data base gives size resolved estimates on particulate emissions, especially organic and elemental carbon emission have been addressed. The data base will be available the fall 2009.

Suggested work in Phase II
The development of the organic chemistry models will continue using both chamber data as well as field experimental data in cooperation with EUROCHAMP, EUCAARI, EUSAAR and

EMEP with the intention to implement the model in the regional 3D models MATCH and EMEP. The organic chemistry in the reference box model will be extended accordingly.
The implementation of SALSA in EMEP and MATCH will be completed and evaluated against the reference box model and EUSAAR data. The evaluation of cloud physics and chemistry the box model will continue with focus on implementation in EMEP and MATCH. The focus is especially on the influence of particles on the cloud formation and precipitation.

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Area 3 Ecosystem impacts of air pollution – nitrogen and acidification

Area coordinator: John Munthe, IVL

Objective: The objective is to improve our understanding of short and long term effects of nitrogen deposition with respect to recovery from acidification, biodiversity and eutrophication and to provide scientific support for measures to reduce negative impacts on the environment.

Participating organizations: IVL Swedish Environmental Research Institute (John Munthe, Filip Moldan, Sofie Hellsten); Lund University (Cecilia Akselsson, Harald Sverdrup); Swedish University of Agricultural Sciences (Annika Nordin); Umeå University (Lars Ericson); Belyazid Consulting & Communication (Salim Belyazid); SkogForsk The Forestry Research Institute of Sweden (Lars Högbom). Cecilia Akselsson was the subprogram coordinator until august 2008, and John Munthe has been the coordinator since then.

Results Phase 1: The Ecosystem area is divided into three main projects, the first aiming at increasing the knowledge about nitrogen (N) cycling in forest ecosystems based on field data, the second aiming at developing dynamic N models and the third about future impacts of forestry, deposition and climate change. The last part, about future impacts, will be activated in phase 2 according to the original plan. The cooperation between different projects and subprojects has started in phase 1 and will be intensified in phase 2.

During the first phase of SCARP existing data from N addition experiments, national monitoring and forestry research have been compiled as related to the requirements for the dynamic modelling development. A comprehensive literature review was performed, summarizing the present research status of important N processes as related to the dynamic ecosystem model ForSAFE (Belyazid et al. manuscript). This review is an excellent basis for model development with emphasis on the N processes.

In a parallel literature review (Fuhrman et al. manuscript), a compilation of a Swedish N addition experiments at Skogaby, Billingsjön, Gårdsjön, Asa, Kågeröd, Tönnersjöheden, Toftaholm, Mangskog and Svartberget in Sweden has been performed. The sites were selectedbased on availability of data needed to describe the key processes to model the N cycling in these ecosystems, both across the ecosystem boundaries (inputs and outputs) and internal N cycling. This compilation was done with N cycling models in mind. It includes data published in opened literature, in reports and not published yet, obtained by involving site managers, when appropriate. The material will be used in Phase II for model runs, development and testing.

Further, an extensive analysis of N concentrations in soil water within the Throughfall monitoring network has been carried out. Time series of 88 sites all over Sweden have been analysed, in order to investigate gradients of nitrate leaching from growing forests. This study, together with other national N approaches e.g. mass balance calculations and ForSAFE modelling, are presented in a strongly policy-oriented paper (Akselsson et al. manuscript) which will be submitted to a scientific journal in 2009. Parts of the results were presented on the N2007 conference in Brazil in 2007.

The Ecosystem area of SCARP has been run in close collaboration with a newly ended Formas project "Where does added N go in N-rich forests", where soil solutions have been sampled at three forest sites in southern Sweden, and analysed for inorganic and total N. In addition the stable isotope ^{15}N has been added to the soil in order to follow where the added N goes. The soil solution data reveals large differences in N retention capacity between sites of comparable N deposition and stand age. The data also show that high forest production occur even at high (close to N saturation) N losses. Preliminary results have been presented at a the N2007 conference in Brazil and the results will be published during the autumn 2009. Analysis of the ^{15}N samples will be conducted in 2009.

SCARP has contributed to the continuation of important N field experiments, both in Vindeln and in Gårdjön. Gathering and compilation of data from long-term N addition experiments in Vindeln (pine-heath, spruce-forest and mire) simulating low N deposition in north-Sweden, have resulted in a number of publications and manuscripts, e.g. Forsum et al. 2008, Strengbom & Nordin, 2008, Wiedermann et al. 2007 & 2009a & b, Nordin et al. manuscript, Ishida & Nordin manuscript. The main results include data on how plant – parasite interactions are affected by N

deposition and can act as main driver for biodiversity changes. The results are also included in several synthesis papers, books and reports (Bobbink et al. 2009, Nordin et al. 2007, Nordin et al. 2009).

Nitrogen addition to catchment G2 at Gårdsjön continued for all three years of the phase 1, thus completing a total of 18 years of treatment in March 2009. The results from Gårdsjön contributed to the synthesis by Evans et al., (2008) and Goodale et al., (submitted). Experimental data were used for model development and tests (Futter et al., 2009, Belyazid and Moldan, 2009). Apart from INCA-N and ForSAFE-Veg, the data were also used for modeling with MAGIC model, to provide material for tests in the ongoing development of nitrogen module in the MAGIC model.

Vegetation was surveyed at Gårdsjön in 1992, one year into the N addition experiment NITREX. The continuation of the N-addition within SCARP opened the possibility to resurvey the vegetation after 16 years of adding 40 kg N/ha/yr. The vegetation re-survey was undertaken in 2008. It was accomplished in co-operation with The Norwegian Forest and Landscape Institute, with additional funds provided by Naturvårdsverket. The results will be published on its own, but were also used in development of criteria for setting critical loads for nitrogen based on changes in vegetation in co-operation with project 3.2.

SCARP was central in organizing an international workshop about empirical critical loads, "Nitrogen critical loads for terrestrial ecosystems in low deposition areas" in Stockholm 29-30 March 2007, which resulted in lowered critical loads for northern ecosystems (United Nations, Economic and social council, 2007). Further, new concepts for calculating critical load of N have been developed based on vegetation effects. The international workshop "Indicators for modelling critical load of N based on vegetation effects" in Gothenburg in September 2007 was central in this activity (Belyazid et al., 2007). Results were also presented in the N2007 conference in Brazil.

N dynamics in forest soils have been developed in the ForSAFE-VEG model in the first phase of SCARP. The model development was based on a thorough review of current knowledge about N transformation processes and pathways in forest ecosystems, including biota and soil (Belyazid et al, manuscript). The progress in N dynamics in the ForSAFE model focused on nitrogen transformation processes in soils in view of simulating the nitrification and denitrification processes as well as estimating N immobilization and gaseous emissions from soils. The new N processes module is based on the aerobic/anerobic balance in the soil, and uses climatic and chemical conditions to steer the rates on N transformation in the soil (Belyazid, 2008).

Experimental data from Gårdsjön were used for model setup and testing, and for evaluating the performance of the model on an integrated biogeochemical ecosystem including the composition of the ground vegetation (Belyazid and Moldan, 2009). This study was also used to investigate the feasibility of using changes in the ground vegetation to estimate critical loads of nitrogen deposition. The method developed in this study was included in the basis of the recommendations presented to Coordinating Centre on Effects (CCE) of the LRTAP convention.

The recommendations of the critical loads of deposition based on the composition on the ground vegetation as a biological indicator resulted in a follow up by the CCE that may lead to a European wide application of the prototype developed within SCARP. The method and testing of the critical loads estimation based on vegetation composition are described in Belyazid et al. (2009), and were presented as the keynote speech at the 19tth CCE Workshop on dynamic modelling of air pollution impacts and the further assessment of nitrogen effects, May 2009, in Stockholm.

SCARP also contributed to investigating the effects of climate change on forest ecosystems in Sweden, with a view of how the expected changes in climate will change carbon stocks in soils, affect growth and alter weathering rates (Belyazid, 2007). The results were used as part of the basis of the in-depth evaluation of the environmental quality objective of "Natural Acidification Only".

Further, the MAGIC model was calibrated to the Gårdsjön experiment, and identification of gaps in conceptual understanding of the treated catchment, in co-operation with a NitroEurope project on INCA-N modelling at Gårdsjön (Futter et al. 2009).

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Area 4 Integrated assessment modelling

Area coordinator: Jenny Arnell, IVL

General Objective: The overall objective of this sub program is to provide a basis for optimisation and assessment of future air pollution policies in Sweden and Europe.

Summary of subprogramme

European air pollution policies are today to a great extent depending on the GAINS model. The model is today not only forming the basis for the international agreements as Gothenburg Protocol the NEC Directive but more and more countries are developing their own model systems based on the GAINS European model.

The overall objective of this sub program is to provide a basis for the assessment of future air pollution policies in Sweden and Europe by using the GAINS framework and working in close collaboration with IIASA. It will also form a basis for future optimization of abatement costs following the implementation of policies related to air quality and climate change.

The Phase 1 of the IAM SCARP subprogramme started with a review of GAINS, increased understanding of the model input and structure and creating a link between IIASA and the SCARP IAM for development of a GAINS SWEDEN.

One particular item of the subprogramme has been a thorough consideration on how to include so called non technical measures in the GAINS model system. A method is presented and then used for an assessment of measures within the transport sector. Measures that are analyzed include congestion charge and road pricing.

During the first phase of the SCARP programme, the GAINS Sweden model (http://gains.iiasa.ac.at/gains/SE/index.login?logout=expired) have been initialized. The model is a similar version of the GAINS online (available for the UNFCCC annex 1 and the European version). The model allows a better description of Swedish emissions and control options via the option to adapt the emission factors used to calculate the emissions in the model. Furthermore, the model output is adapted so as to further facilitate communication between SCARP-IAM and Swedish energy projections and emission projections and their format.

One important deliverable of this sub programme is the establishment of the Network for Integrated Assessment Modelling NIAM where SCARP has been one of the responsible parts of the establishment.

One particular activity within the sub programme has been to put together a detailed data set ocf energy-related data for the residential and commercial sector in the EU-27 countries as well as Norway, Switzerland and Turkey (EU-27+3). The purpose was to gather national and European data and establish a database with a format suitable for the GAINS model used by IIASA. The data is then used in the European version of the GAINS model as a basis to estimate future emission abatement possibilities. Focus lies on energy use for heating, cooling, lighting and electrical appliances.

The long term vision of the subproject is to develop a National version of the GAINS model with possibilities for testing, evaluation and improvement of various components of the model system according to priorities set by Swedish environmental authorities and Swedish scientists.

The Integrated Assessment Modelling sub programme consists of four sub-projects. The sub-projects within SCARP-IAM have, however, been reorganized and refocused to some extent based on discussions with the Swedish EPA. The work in the sub-projects is in general closely related. The focus during phase II will lie on further development of the GAINS Sweden model, further incorporation of results from other parts of the SCARP programme as well as further development of the theoretical considerations regarding abatement cost calculations. At the start-up meeting of phase II, new sub-project titles will be developed in accordance with priorities set and discussed with the Swedish Environmental Protection Agency as well as in accordance with developments at IIASA and the GAINS model.

Phase 2

The objectives of the second phase of the sub programme Integrated Assessment Modeling is an extension of the efforts achieved in phase 1 of the sub programme in order to develop a National version of the GAINS model with possibilities for testing, evaluation and improvement of various components of the model system according to priorities set by Swedish environmental authorities and Swedish scientists.

The main objectives of this phase are:

- -Further development of GAINS Sweden through extensive collaboration with IIASA and other SCARP sub programmes such as area 1 and area 2,
- Additional assessment of the transport sector including behavioural and structural changes and their costs and incorporation of these in the other Swedish sectors
- Assessment of transaction costs and review of their impacts in GAINS-Sweden costs effectiveness analysis
- Develop a draft version of GAINS Sweden

The budget of this phase is 2.5 million SEK and distribute evenly among the 3 years of this phase.

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Communication

Since the program is directed towards national and international policy development, communication is a central issue in the program. Much work is therefore directed towards interactions with relevant stakeholders and bodies, including contacts with national agencies, in particular with the Swedish Council for Environmental Objectives and the relevant international bodies under EU, CLRTAP and WHO.

A detailed communication plan was established at the start of the programme. The activities in the plan are compiled in Table 1 together with a compilation of the activities.

In addition, much of the communication within the programme is done by the participating scientists; through ordinary scientific presentations of results (papers, oral presentations etc.). The Programme also has its own web page www.scarp.se.

Seminars, conferences and workshops

A number of workshops and seminars have been organised by SCARP, often in collaboration with other organisations. These include:

Air pollution and climate change
A two day seminar on air pollution 12-13 November 2008 organised together with Naturvårdsverket and IVL. At the seminar, which attracted approx. 150 people, a comprehensive presentation of the program and its results was given. The first day was focused on the interrelations between air pollution and climate and the significance for the transport sector and involved a broader set of speakers including IIASA, the industry and authorities. On the second day, results from the project were presented and discussed from a user perspective in two parallel sessions.

Nitrogen critical loads for terrestrial ecosystems in low deposition areas
29-30 March 2007 in Stockholm. The seminar was organised together with i.a. Swedish Environment Protection Agency and Swedish industries.

Indicators for modelling critical load of N based on vegetation effects
3-4 September 2007 in Göteborg. International workshop. Workshop conclusions on SCARP's web page.

Assessment of air pollution for epidemiological studies
6-7 November 2007 in Göteborg. International workshop. Presentations on SCARP's web page.

Air Pollution and Climate Change — Collaboration for the best results (In Swedish)
12-13 November 2008 in Stockholm. Presentations on SCARP's web page.

SCARP is also involved in the organisation of the international workshop on climate and air pollution to be held in Göteborg 19-21 October 2009.

SCARP and SCARP scientists were also heavily involved in the 3rd Saltsjöbaden Workshop in Göteborg in March 2007 http://asta.ivl.se.

SCARP scientists were involved in the NIAM/APRIL Workshop, Reducing the Environmental Impact of Transport with Behavioural Change, 8-9 January 2009, London. (www.niam.scarp.se)

Books

SCARP scientists are main authors in a book on air pollution and climate change to be published in October 2009. The book will form a background for the workshop 19-21 October in Göteborg.

Interactions with general public, media etc.

Several of the programme participants have communicated research and results with ordinary public media through articles in newspapers, press releases, articles in specialized journals etc.

Table 1: Communication plan and SCARP communication activities during phase 1.

Activity	Periodicity	Target group	Responsible	Activities
Web page in Swedish and English	Available by 1 Jan 2007	Public, Scientific community, Experts, Media	Information officer	The web page has been working since the program start www.scarp.se
Progress reports	Yearly	Naturvårdsverket,	Information officer. Program coordinator	Yearly progress reports have been established in connection with annual meetings.
Popular summaries	Yearly	Interested public, media etc	Information officer. Program coordinator area coordinators	Was taken out from the program due to cut in the program budget.
Program plans	Yearly	Naturvårdsverket. Internal follow-up	Program coordinator	Representatives from Natuvårdsverket are invited to all internal meetings even the management group meetings.
Internal information on external processes of relevance for SCARP. This activity contains information from policy related processes CLRTAP, EU, Swedish environmental objectives etc..	In connection with meetings. At least every ½ year	SCARP participants	Program and area coordinators.	All internal meetings include an agenda item at which most recent policy activities nationally and internationally are handled.
Contacts with national stakeholders. Participation in seminars will be encouraged.	Yearly.	Local regional and national environmental and health administrations. The industry.	Program and program areas coordinators.	See the list of seminars. In particular the seminar 12-13 November 2008 had a wide participation from various stakeholders.
Organisation of SCARP seminar.	At least one wide seminar during phase 1	Local regional and national environmental and health administrations. The industry	Program and program area coordinators	See the list of seminars.
Increase the ability to communicate results to policymakers and the public.	The yearly meeting in the autumn 2007.	Participants in the SCARP program, in particular young scientists	Information officer	No particular activity was organised.

Connections to policy development

The program was set up in order to support national and international policy. Swedish environmental policies are mainly based on the National Environmental Objectives, decided by the Parliament. The program is mainly relevant for three of the environmental objectives:

- Clean Air
- Only natural acidification
- No eutrophication

With respect to international air pollution policies and in particular EU policies, the programme has the intention to publish results in relation to the revision of the EU thematic strategy, which is expected to start its process and publish its results sometimes after 2012, i.e when the program is about to finish.

Internationally, the results from the programme area 1, are most likely to be important for the revision of WHO documents. They will also be of importance for the regulations of emissions and implementation of EU directives on air quality. Results from the programme areas 2, 3 and 4 are directly connected to processes under CLRTAP and results are continuously reported and discussed in relevant working groups.

Many of the scientists have also been involved in national and regional/local organisations and processes connected to the National Environmental Objectives and their implementation.

Table 2: Key involvements of SCARP scientists in international policy organisations.

CLRTAP - EMEP	Peringe Grennfelt David Simpson John Munthe
CLRTAP - TFMM	HC Hansson David Simpson Christer Johansson
WHO/ CLRTAP – TF Health	Bertil Forsberg
CLRTAP – TF Mapping och ICP:s	Filip Moldan John Munthe Harald Sverdrup Salim Belyazid Sofie Hellsten Annika Nordin Cecilia Akselsson
CLRTAP – TF IAM and NIAM	Stefan Åström

Programme management

The programme is managed through a programme director (Peringe Grennfelt) and the team of programme area coordinators:
Programme area 1: Göran Pershagen
Programme area 2: HC Hansson
Programme area 3: John Munthe
Programme area 4: Jenny Arnell.

In addition, the program has a communication officer, who is responsible for SCARP's web page, internal communication and other outreach activities. The communication officer has been Jenny Arnell until autumn 2007 and thereafter Sofie Hellsten.

The programme has formed a management group consisting of the program director, the programme area coordinators and the communication officer. The management board meets regularly through teleconferences (8-10 times a year). Representatives from Naturvårdsverket are always invited to take part in the management group meetings. In addition there is an annual meeting every year, to which all participants and key stakeholders are invited.

Each programme area has then its own organisation and scientists within these meet regularly.

Some comments to phase 2

The objectives and overall research directions for phase 2 were outlined in the original proposal. As shown in the descriptions of the four areas as well as in the detailed descriptions of each project (Appendix 1) the programme will still be divided into the four areas. In addition to the outlined we intend to apply for additional funding for integrating the activities within the areas in order to obtain an additional value of the programme. The integration will mainly go along three lines:

- Improving dose descriptions for the assessment of human health effects (Synthesizing knowledge from areas 1 and 2). This activity is intended to further develop and harmonize models for Swedish urban areas to include appropriate emission descriptions, detailed particle parameterisation and an improved health impact description.
- Improving parameterisation of N effects in ecosystems in order to include N dynamics in integrated assessment models.
- Implementing results from SCARP research into integrated assessment models (GAINS Sweden).

SCARP approached Naturvårdsverket in the beginning of 2008 with such a proposal on these issues together with improvements on communication. The proposal was at that time essentially rejected with the comment that these should be considered in connection with the start of phase 2.

Budget phase 2

The same amount of money is allocated to the programme for phase 2 as for phase 1. We also intend to have the same division between aeras. The final decision on allocation of money to projects will be done in connection with the submission of the final application to the Swedish Environmental Protection Agency in October. In Table 3 the budget allocation between areas is given.

Table 3. The budget allocation for Phase II (2010-2012)

Scientific areas	Area 1	5584	
	Area 2	3802	
	Area 3	3659	
	Area 4	2995	
	Sum		**16040**
Program coordination	Program management	469	
	Program communication	333	
	Program coordinated activities	258	
	Sum		**1060**
Overall budget			**17100**

Staff

A large number of scientists have been involved in the programme during phase 1. In Table 4 all peoples associated with the research is compiled.

Table 4. All people associated with Scarp (Phase I).

	Name	Position	Male/Female	Work extent (%)
1.1	Tom Bellander	Associate professor	Male	10%
	Magnus Wickman	Professor	Male	5%
	Inger Kull	PhD	Female	10%
	Göran Pershagen	Professor	Male	5%
	Olena Gruzieva	PhD student	Female	100%
	Tomas Lind	Statistician	Male	10%
	Emma Nordling	Envrionmental Health Officer	Female	20%
	Saskia Willers	Post-doc	Female	20%
	Christer Johansson	Associate professor	Male	5%
	Kristina Eneroth	PhD	Female	10%
1.2	Tom Bellander	Associate professor	Male	10%
	Sven-Göran Eriksson	Statistician	Male	50%
	Petter Ljungman	PhD	Male	10%
	Mårten Rosenqvist	Professor	Male	5%
	Payan Dadvand	Post-doc	Male	25%
	Christer Johansson	Associate professor	Male	5%
	Bertil Forsberg	Associate professor	Male	5%
1.3	Bertil Forsberg	Project leader, Ass prof	Male	10%
	Helen Bertilsson	Nurse	Female	60%
	Mona Svensson	Research assistant	Female	30%
	Bengt Järvholm	Prof	Male	2%
	David Olsson	Statistician	Male	20%
1.4	Bertil Forsberg	Project leader, Ass prof	Male	10%
	Lars Modig	PhD, Researcher	Male	75%
	Bengt Järvholm	Prof	Male	2%
	Kadri Meister	PhD, Statistician	Female	10%
	Lennart Jonsson	GIS technician	Male	20%
1.5	Kristina Wass	Epidemilogy assistant	Female	30%
	Santosh Dahgam	PhD	Male	35%
	Anna-Carin Olin	MD, Assoc professor	Female	20%
	Fredrik Nyberg	MD, Assoc professor	Male	10%
	Lars Modig	Post doc	Male	40%
1.6	Kristina Wass	Epidemilogy assistant	Female	10%
	Santosh Dahgam	PhD	Male	35%
	Anna-Carin Olin	MD, Assoc professor	Female	10%
	Fredrik Nyberg	MD, Assoc professor	Male	5%
	Lars Modig	Post doc	Male	30%
	Annicka Rosengren	Professor, MD	Female	2%
	Lena Björk	Nurse, post doc	Female	5%
1.7	Payam Dadvand	Postdoc	Male	100%

	Tom Bellander	Associate professor	Male	10%
	Göran Pershagen	Professor	Male	15%
	Anders Lundin	Hygienist	Male	50%
	Michal Korek	Public health officer	Male	15%
1.8	Sviatlana Panasevich	PhD-student	Female	50%
	Tom Bellander	Associate prof	Male	5%
	Göran Pershagen	Professor	Male	10%
	Ulf deFaire	Professor	Male	5%
	Fredrik Nyberg	Associate prof	Male	5%
1.9	Thomas Sandström	Professor	Male	
	A. Blomberg and others			
1.10	Thomas Sandström	Professor	Male	
	Maj-Cari Ledin		Female	
	Maria Sehlstedt		Female	
	Jamshid Pourazar		male	
	Anders Blomberg		Male	
1.11	Gerd Sällsten	assoc prof	female	10%
	Lars Barregård	prof	male	10%
	Pernilla Gustafson	PhD, occupational hygienist	female	5%
	Sandra Johannesson	PhD-student, occup & environ Hyg	female	5%
	Leo Stockfelt	PhD-student, occup & environ Hyg	male	5%
	Lena Andersson	PhD-student	female	5%
	Bo Stranberg	assoc prof	male	5%
	Peter Molnar	PhD	male	
1.12	Gerd Sällsten	assoc prof	female	5%
	Lars Barregård	prof	male	5%
	Peter Molnar	PhD	male	5%
	Eva M Andersson	assoc prof	female	5%
	Annika Rosengren	prof	female	
	Leo Stockfelt	PhD-student	male	
2.1	David Simpson	Adjunct Professor	male	
	Anna Derneryd	PhD student	Female	
	Mattias Hallquist	PhD, D Docent	male	
2.2	Cecilia Bennet	Researcher, Ph D student(GU)	Female	40%
	Michael Kahnert	Researcher, PhD	Male	8%
	Robert Bergström	Researcher, Ph D student(GU)	Male	6%
	Lennart Robertson	Researcher	Male	3%
2.3	Christer Johansson	Assoc professor	Male	20% (for 3 years)
	Deng Shunxi	Guest professor	Male	100% (for one year)
	Emma Hedberg	Post doc	Female	75% (for 6 months))
2.4	Kristina Stenström	Lecturer	Female	30%
	Johan Genberg	Ph D student	Male	80%
	Mattias Olsson	Research enigineer	Male	40%
	Erik Nilsson	PhD Student	Male	20%
	Erik Swietlicki	Professor	Male	5%
3.1	Cecilia Akselsson	Project leader	Female	5 %

	Annika Nordin	Researscher	Female	10 % (2007-2009)
	Filip Moldan	Researscher	Male	10 %
	Lars Högbom	Researscher	Male	5 %
	Magdalena Wiedermann	Researscher	Female	20 % (2007-2008)
	Åsa Forsum	Researscher	Female	10 % (2007-2008)
	Ann Sehlstedt	Researscher	Female	50 % (2007-2009)
	Filippa Fuhrman	Researscher	Female	20 %
3.2	Salim Belyazid	Project leader	Male	10 %
	Filip Moldan	Researscher	Male	15 %
	Harald Sverdrup	Researscher	Male	5 %
	Annika Nordin	Researscher	Female	10 % (2007-2009)
4.1	Mohammed Belhaj	Project leader	Male	15%
	Lena Nerhagen	Researcher	Female	10%
4.2	Mohammed Belhaj	Researscher	Male	15%
	Stefan Åström	Project leader	Male	10%
	Maria Lindblad	Researscher	Female	5 % (1 year)
	Jenny Arnell	Researscher	Female	10%
	John Munthe	Head of Department	Male	10%
	Håkan Blomgren	Researcher	Male	5%
4.3	Stefan Åström	Project leader	Male	20%
	Maria Lindblad	Researscher	Female	10 % (1 year)
	John Munthe	Head of Department	Male	10%
	Salim Belyazid	Researscher	Male	10 % (1 year)
4.4	Stefan Åström	Researscher	Male	20%
	John Munthe	Project leader	Male	5%
4.1	Mohammed Belhaj	Project leader	Male	15%
	Lena Nerhagen	Researcher	Female	10%
5.1	Peringe Grennfelt	Programme co-ordinator	Male	10%
5.2	Sofie Hellsten	Programme communication	Female	7%

Additional funding

SCARP is dependent on additional funding. For information we have compiled the most important sources for this funding and the amount available in phase 1.

Area	Project	Name	Project leader	Organisation	Total Phase I	Addifional funding
1	1	Exposure to traffic related air pollution in early life, lung function and airway disease in 8-year-old children	Tom Bellander	IMM	475	EMFO, 1 150 000 SEK, 2007-2009
	2	Short-term health effects in susceptible subgroups, using newly developed source-specific local time series of air pollution	Tom Bellander	IMM	760	European Union, 270 000 €, 2003-2005
	3	Health effects of short-term and cumulative seasonal exposure to road dust and wood smoke particles at real-world exposure conditions	Bertil Forsberg	OEM UmU	714	ALF (funds for clinical research), 668 000 kr, 2007-2008
	4	Long-term exposure to traffic exhaust and incidence of obstructive airway disease in a prospective cohort – planning grant	Bertil Forsberg	OEM UmU	166	EMFO, 800 000 kr, 2007-2008, Asthma and Allergy Foundation, 175 000 kr, 2008-2009
	5	Is exposure to particulate air pollution associated with exhaled nitric oxide and blood markers of inflammation?	Anna-Carin Olin	OEM GU	664	FAS: 5 600 000 SEK 2005-08, Formas: 1 500 000 SEK 2004-07
	6	Is long-term exposure to particulate air pollution associated with an increased risk for ischemic heart disease	Anna-Carin Olin	OEM GU	285	VGR Reaserch school; PhD, 2 500 000; 2009-12.
	7	Cohort study on total public health burden related to long term-exposure to air pollution	Göran Pershagen	IMM	166	European Union, 3 000 000 SEK, 2008-2012
	8	Long term exposure to traffic related air pollution and genetic susceptibility in relation to myocardial infarction	Göran Pershagen	IMM	380	Swedish Heart and Lung Foundation, 800 000 SEK, 2009-2010
	9	DISOZPOLL: Diesel and ozone effects on the cardiovascular system	Thomas Sandström	RMA UmU	572	
	10	PMMECH - Mechanisms behind particulate matter air pollution induced toxicological effects	Thomas Sandström	RMA UmU	381	
	11	WOODPART-2: A human experimental model using wood smoke for studies of acute effects of particulate air pollution on inflammation, coagulation and oxidative stress	Gerd Sällsten	OEM GU	570	FAS, 1000 KSEK (another experiment), 2007-2009, Research School, PhD-student, 2009-2012
	12	Health effects of long range transported particles: a population study using air mass trajectories	Gerd Sällsten	OEM GU	176	FAS, Post doc Peter Molnar, 2009-2011
		Synthesis			275	
		Sum			**5584** 0	

2	1	Chemical Modelling of Aerosol Formation	David Simpson	Met.no & CTH	1046	
	2	Developing dynamic particle description including formation, growth and deposition	Cecilia Bennet	SMHI	1046	Currently no other funding
	3	Construct emission databases for dynamic particle models and validate urban models concerning particle size distribution and chemistry	Christer Johansson	ITM	1140	EUCAARI (EU-projekt) ca 300 000 SEK, Folkrepubliken Kina (1 år post doc) ca 300 000 SEK
	4	Aerosol OA sampling and 14C-analysis	Kristina Stenström		570	
		Sum			**3802**	
3		Coordination and communication	John Munthe	IVL	285	
	1	Nitrogen cycling in forest ecosystems	Cecilia Akselsson	IVL	2053	NV-projekt, 195 200:-, 2008. Krondroppsnätet, Formas (Lars Högbom) Where does N goes in N-rich forests? 2830000 SEK, Formas (Annika Nordin), 1600 KSEK, 2006-2009, and 2240 KSEK, 2009-2011
	2	Dynamic nitrogen model development and evaluation	John Munthe	IVL/LTH	1321	
	3	Future impacts of forestry, deposition and climate change	Filip Moldan	IVL	0	
		Sum			**3659**	
4		Coordination and communication	Jenny Arnell	IVL	285	
	1	Costs of non-technical measures in IAM models - theoretical considerations	Mohammed Belhaj	IVL	760	No additional funding
	2	Inclusion of non-technical measures in the GAINS model	Stefan Åström	IVL	619	No additional funding
	3	Development of a GAINS Sweden	Stefan Åström	IVL	536	NMR, 1600 KSEK, 2007-2009 Swedish Energy Agency, 240 KSEK, 2008-2009 FORMAS, 240 kSEK, 2008-2009 Swedish Environmental Protection Agency, 100 kSEK, 2008-2009
	4	Integrated assessment modelling at a national scale	John Munthe	IVL	795	
		Sum			**2995**	
5	1	Program management	Peringe Grennfelt	IVL	469	
	2	Program communication	Sofie Hellsten	IVL	333	
	3	Program coordinated activities	Peringe Grennfelt	IVL	258	
		Sum			**1060**	