The Mistra Programme:

ASTA

International and National Abatement Strategies for Transboundary Air Pollution

Revised Programme Plan for 2002

Göteborg November 2001
Approved by the ASTA board 26 November

This document is based on the ASTA Programme Plan for 2000-2002 submitted to ASTA in Nov 1999 and approved by the MISTRA secretariat 20 December 1999.

Preface

In October 1998, the Board of Mistra decided to support the research programme *International and National Abatement Strategies on Transboundary Air Pollution* (ASTA). A support of 22 MSEK was given for the four-year period 1999-2002 with 4 MSEK for 1999. The decision also requested the submission and approval of a revised programme for 2000-2002 taking into account comments by the scientific review of the programme, the views of different stakeholders and points given by the Board of Mistra. The revised programme plan was submitted to Mistra 29 November 1999 and was approved 20 December 1999.

The programme plan for the period 2000-2002 was based on a total budget of 31 MSEK, assuming funding from additional sources to a total amount of 9 MSEK. There have however been problems receiving the additional funding and during the autumn 2000 an agreement was reached on a volume of just below 28 MSEK. The reduction in financial support and the late agreement has forced us to make changes in the overall programme and to delay some of the activities. The changes have almost exclusively fallen upon the integrated programmes, i.e. *International Centre for Evaluation and Assessment*; *International Assessment Modelling* (A1) and *National strategies for emission control and land use – a national platform* (A2).

During 2001 we have received additional support for the programme from the National Board of Forestry, in particular directed to the A2 sub-programme, and ASTA has today a budget of about 29.8 MSEK for 2000 - 2002.

Some activities and projects have received financial support in addition to the basic funds from the ASTA programme. This support is mainly given to workshops and activities under A1:1 and to PhD students in C3. This support is not included in the budgets presented in this programme plan.

In the programme for 2002 most of the background description from the previous years' programmes have been omitted. These parts can be found at http://asta.ivl.se.

Göteborg 30 November 2001

Peringe Grennfelt

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Summary

The objective of ASTA is to support international and national strategies on transboundary air pollution with scientific knowledge and data. Within the UNECE Convention on Long-Range Transboundary Air Pollution (CLRTAP) and the European Union, decisions have recently been taken or will be taken that will lead to a substantial improvement of the regional air pollution situation in Europe. These decisions are to a large extent based on quantitative relationships between activities in the society and the effects in the environment and to human health. Effect-based cost-effective international strategies on transboundary air pollution have been developed for acidification, eutrophication and photochemical oxidants. The actual international agreements and EU directives will however not be sufficient to solve the problem. Sensitive lakes and ecosystems in Scandinavia will still suffer from acidification, natural and semi-natural ecosystems will still be damaged by excessive nitrogen deposition, elevated ozone and particulate concentrations will still threat human health. Future control measures will therefore be necessary.

This proposal aims to improve the scientific knowledge and to further develop policy-directed tools for future international negotiations, which are expected to take place in the period 2003-2005.

In addition to the international strategies, there is also a need for tools and knowledge for the development of national strategies within areas where the influence of transboundary air pollution is substantial. These areas include the future use of forests as an energy resource and the effects caused by the extraction of biomass, assessments of emission reductions and their environmental and health effects within the traffic sector, the future needs for liming and other mitigation measures in lakes and forest soils. This proposal includes also the development of tools and methods for these strategies.

The programme includes scientific research on integrated analyses, on basic processes and mechanisms and on social aspects of the international negotiations and agreements. The following sub-programmes are included:

Integrated projects
- International Centre for Evaluation and Assessment
- International Assessment Modelling – inclusion of dynamic effects and environmental benefits in integrated assessment modelling
- National strategies for emission control and land use – a national platform

Sociological aspects
- Scientific processes behind abatement strategies – A social science perspective

Source-effect relationships
- Acidification - Recovery from acidification; experimental research and modelling
- Nitrogen-induced ecosystem changes; vegetation and ecophysiological responses
- Ground-level ozone - effects on forests and crops
- Particulate air pollution – concentrations, transport and sources

The overall budget for the first phase of the programme, 1999-2002, is approx. 35 million SEK and for the period 2000-2002 30 million SEK.

The situation

The main purpose of the ASTA programme is to support regional air pollution policies under the Convention of Long-Range transboundary Air Pollution (CLRTAP) and the European Union. Under both organisations, revisions of present agreements (the National Ceilings Directive and the Gothenburg Protocol) are expected to take place within a few years and the revisions are expected to be based on scientific knowledge compiled in integrated assessment models and similar tools.

The agenda for the revisions has been set during 2001 and there is today a timetable for preparation of integrated assessments and optimisations for the Gothenburg Protocol and the EU National Emission Ceilings Directive (NEC). According to agenda, the EU work will lead to a proposal for new EU legislation at the end of 2004. The revision of the Gothenburg Protocol is expected to take some longer time and the scientific material does not need to be available until 2005 or 2006.

This also means that the ASTA programme now can point out the needs and the timescales for deliveries of scientific knowledge and data into the process. Most of the deliverables for the integrated assessment process within the CAFE programme need be ready during 2002 and 2003. For CLRTAP the timeframe is somewhat longer. The agenda is however primarily directed towards the needs for integrated assessment modelling and calculating optimised control strategies. Other needs, not directly a support to the integrated assessment optimisations, e.g. assessments of cost-benefits, uncertainty analyses etc., could be fed into the processes at a later stage.

The national part of the ASTA programme is directed towards the revisions of the Swedish environmental objectives and to support decisions on future use of biomass as an energy source. The timetable for the revisions of the environmental objectives is not fixed yet but is expected to be about the same as in the international agenda.

The first phase of ASTA will end in 2002 and more specified work in relation to the national and international agendas will be worked out in the preparation of activities for the next phase.

Goals

The goals of the ASTA programme as stated in the original proposal are:

* to produce scientific material of importance for international abatement strategies of transboundary air pollution, and
* to develop tools for national strategies within sectors and other areas, where transboundary air pollution is of importance.

Research Approach and Realisation

The research approach of the first phase of the ASTA programme has been to strengthen the scientific background material within crucial areas and where Sweden traditionally has a high competence. Integration of knowledge into models and assessments for an improved understanding has so far received less attention. From the autumn 2001 the integration of

knowledge into conceptual and mathematical models has become a stronger part of the ASTA programme, mainly due to the improved financial situation.

In one of the sub-programmes, the recovery processes of soils and waters from acidification are investigated (C1:1). The large experiment in the sub-programme, the roof experiment at Lake Gårdsjön went into an new phase this summer when the roof was taken away. After two years of follow-up studies, the roof experiment is expected to finish the measurements during 2003.

The experimental data from Lake Gårdsjön are used for preparation of models for general assessments of future status of soils and lakes. The work in the sub-programme has been accompanied with workshops in order to form *con sensus* around how recovery should be handled in integrated assessment models. ASTA has organised two such workshops and will arrange a third one during 2003.

There are important links between the acidification activities under programme area C and the activity devoted to the development of national strategies in relation to tranboundary air pollution (A2). The interaction between deposition of transboundary air pollution to forest ecosystems and local land use practices is an important aspect of the programme. Forest harvesting inevitably causes a flux of base cations from the forest, which leaves a memory in the soil in terms of acidification and a loss in base saturation. Since the deposition of acidifying compounds is presently decreasing, the balance between acidification caused by deposition and harvest is likely to become shifted towards the impact of forestry. The extent to which this happens is, however, dependent on forest practices and the measures taken to counteract these effects e.g. by redistribution of ashes and vitalisation. The ASTA programme will support decision-making by providing information on sustainability aspects of forestry, considering the limits set by transboundary air pollution and the activities going on in other sectors of the society (i.e. energy production, traffic, industry).

The ASTA sub-programme on nitrogen is directed towards studies of changes in species composition from nitrogen deposition. The project activities are directed towards the study of ecophysiological (C2:1) and ecological (C2:2) processes associated with increased inorganic nitrogen availability. In southern Sweden, where the deposition of nitrogen is and has been much higher, species composition in deciduous forests are investigated in order to establish relationships between nitrogen deposition, stand and soil characteristics and species composition (C2:3). The results will be used as a basis for further development of critical loads for eutrophication effects of nitrogen. As in the case of critical loads for acidification the critical loads for nitrogen will be developed towards more dynamic concepts. These projects will also contribute with data and concepts for sub-programmes A1:2 and A2.

The activity on ozone is directed towards the development of flux-based relationships between ozone exposure and plant response. This is a necessary step in order to move from the concentration based risk assessment (so called Level I analysis) to estimates of actual effects in terms of yield loss etc. (so called Level II analysis). During the last 15 years Swedish scientists have produced a substantial amount of empirical data on crops and forest trees which will be used for this purpose to make economic estimates of ozone-induced effects in general and as a support for the next negotiations on transboundary air pollution in particular.

In the near future effects from fine particles are likely to become increasingly important for the European abatement strategies. Since the long-range transport perspective on fine particles has emerged relatively recently, there is a need to increase the basic empirical understanding of the magnitude of the problem and of the processes involved. The ASTA sub-programme on particles (C4) is devoted to quantify the regional transport of particles and identify the most important processes behind particle formation and dynamics in the atmosphere.

In many ways the negotiations concerning reductions of transboundary air pollution in Europe under the UN ECE convention has been a success story all the time since it was signed in 1979. Progress has been made to an extent, which was not expected at the outset of the process. In order benefit from the experiences made, one part of the ASTA programme (activity B) is directed towards social sciences. The aim of the activity in this sub-programme is to analyse and evaluate the links between scientific research and policy decisions, including the links between international and national processes. An understanding of these relationships will be useful for the outline of further actions.

Synthesis of information is the backbone of the ASTA programme. An important activity within the ASTA programme is therefore to make use the scientific data provided by the other parts of the ASTA programme as well as information coming from research groups working with relevant questions elsewhere in Europe. Such activities are compiled in one sub-programme (A1), in which scientific data will be used for the development of models, assessments studies etc.

The assessment activities are co-ordinated in a Centre for Evaluation and Assessments and include workshops and seminars, support and scientific contributions to important conferences and compilations of facts relevant to the negotiation processes on transboundary air pollution. More specifically, the activities under A1 will cover questions like:

* improvements of tools for Integrated Assessment Modelling,
* development of the critical loads concept,
* evaluation of the various environmental issues concerning nitrogen in terrestrial ecosystems in a broad concept,
* evaluations of economic and other benefits as a result of reduced emissions of long-range transported air pollutants,
* the interrelationship between abatement strategies concerning transboundary air pollution and climate change etc.

Another part of the work under A1 is directed to the development of model tools for assessing the dynamics of environmental effects from the regional air pollution. The objective is to support RAINS and other integrated assessment models with tools for coming policy work. The research activities under programme area C will be continuously integrated in the synthesis work of ASTA by using the results and expertise in the different activities. A certain project under A1 will be devoted to the further development of models and tools for the assessment of effects and their costs.

Collaboration

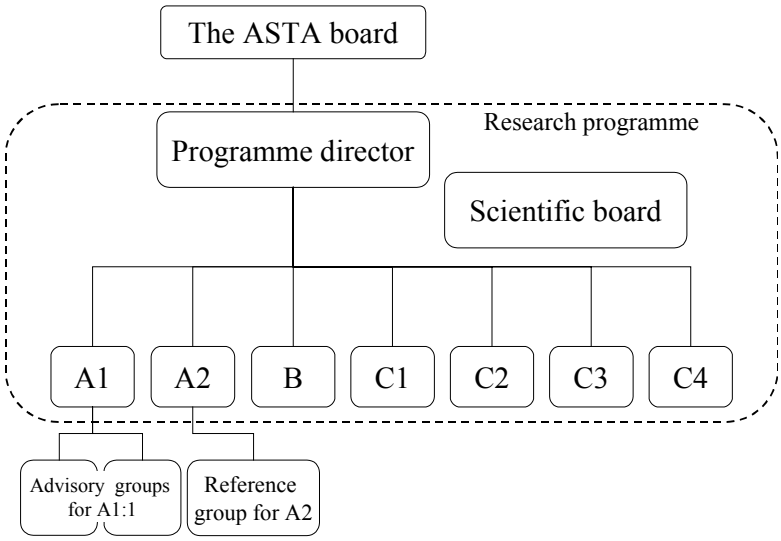
The programme should be seen in the context of all the international activities in the field of transboundary air pollution. In all sub-programmes contacts will be sought and collaboration established with international projects and programmes. A number of such contacts have already been established and will further be elaborated in the description of the sub-

programmes. Of certain importance are the activities in the Nordic countries (Denmark, Finland, Norway) and contacts have been established with the main scientists and programme leaders in these countries. Contacts have also been established with scientific research programmes in United Kingdom, the Netherlands and Germany.

Collaboration with national programmes and other activities is also of crucial importance. A close collaboration is already at hand with the Mistra programme on sustainable forestry in Southern Sweden (SUFOR) and the programme Remote Sensing for the Environment (RESE). Other collaboration activities are under discussion e.g. with the Mistra programmes SWECLIM and LUSTRA. (Information available at www.mistra-research.se.

Programme structure

The structure of the programme is presented in the figure below.



Programme deliverables

The deliverables from the project will be (notations within parentheses refer to the different sub-programmes).

- More than 25 publication in refereed international journals. More than 25 reports and other scientific contributions.

- More than six PhD or licentiate degrees (most of them in the period 2003-2005).

- More than eight assessment reports on crucial issues for the further negotiations on transboundary air pollution (A1:1, A1:2). A majority of the reports will be prepared in collaboration with scientists in other countries and in collaboration with relevant international organisations (CLRTAP, EU, Nordic Council of Ministers, and marine conventions). The reports will be directed to the scientific community, experts and policy-makers within the field of international transboundary air pollution. Issues to be considered are:

- *scientific needs for revisions of protocols and strategies*
- *second generation concepts and criteria on environmental goals*
- *dynamic aspects of effect-based control strategies*
- *interactions with climate change issues on control strategies*
- *interactions with climate change issues on setting of critical loads*

- Model tools for the assessment of ecosystem effects in a dynamic perspective (A1:2) and for the assessment of national policies on issues where transboundary air pollution is of particular importance (A2). The outcome of the ecosystem effects part (A1:1) should during the programme period be implemented in integrated assessment models. The tools for national policies (A2) should be implemented for the assessment of national emission control strategies and biomass harvest strategies in relation to national environmental goals.

- Dose-response relationships for sulphur and nitrogen deposition under dynamic conditions and for ozone under varying climatic conditions (C1, C2, C3). The sub-programmes will lead to a better parameterisation of critical loads and critical levels and other effect-based concepts.

- Basic knowledge and quantitative determination of the importance of long-range transported particle fractions (C4). The results from the sub-programme should be implemented in the EMEP structure giving better parameterisation of particle formation, transport and deposition.

- Assessment of the links between scientific research and policy decisions within the field of transboundary air pollution including a comparison with other international regimes. (B) The role of different actors (scientists, experts, governmental administrators etc.) will be clarified.

- The direct interaction with the international policy organisations on transboundary air pollution and an increased understanding nationally and internationally of the problem and its solutions are also major deliverables from the programme.

A detailed list of the deliverables and their revisions is presented in Appendix 1.

Programme management

The programme management includes Scientific co-ordination of the ASTA programme (D1), Communication of the results of the ASTA programme (D2) and Economic administration (D3).

D1 Scientific co-ordination of the ASTA programme

Budget 2000: 570 kSEK
2001: 570 kSEK
2002: 570 kSEK

Project leader: Peringe Grennfelt, Swedish Environmental Research Institute IVL, Göteborg

Objective: The objective is to lead the ASTA programme to the fulfilment of its overall objectives. It covers the overall scientific leadership, meetings with the participants of the programme and meetings with the board of the programme. It includes contacts with the scientific community working in related national and international programmes and projects. It also includes a continuous evaluation and assessment of activities and results in other programmes and projects and if necessary suggestions on changes in the programme direction and structure.

Work plan: The Board of the ASTA programme meets 4-5 times every year. The board comprises the following persons:

Lars Lindau, Swedish Environmental Protection Agency, Chairman
Anton Eliassen, Norwegian Meteorological Institute
Gunnar Hovsenius, Elforsk
Sven A Svensson, National Board of Forestry

Associated members to the board are

Anna Lundborg, Swedish National Energy Administration
Jan Nilsson, Mistra

ASTA has an internal group for the scientific leadership of the programme. The group consists of the following scientists (sub-programme responsibility within parenthesis):

Peringe Grennfelt	Programme director, A1:1
Harald Sverdrup	A1:2
Olle Westling	A2
Göran Sundqvist	B
Per Warfvinge (until Aug. 01); Mattias Alveteg (from Aug. 01)	C1
Torgny Näsholm	C2
Håkan Pleijel	C3
Hans Christen Hansson	C4
John Munthe	Deputy director
Helena Danielsson	Programme secretary

Associated member of the group is Ulla Bertills, Swedish Environmental Protection Agency. The group meets approximately 4-5 times per year or, if needed, more frequently.

Once every year, all scientists in the programme meet to present and discuss scientific results and to handle various administrative issues.

Reports: Every year there will be a scientific report from ASTA. In addition, a yearly report aimed at a broader spectrum of readers will be produced. This report will be published either in English or Swedish or in both languages in parallel. There might be a reason for writing separate reports for the Swedish and the international community. The ASTA board will set the priorities for this issue. The organisation of the ASTA programme is outlined in the figure below.

D2 Communication of the results of the ASTA programme

Project leader: Peringe Grennfelt, Swedish Environmental Research Institute IVL, Göteborg

Budget 2000: 230 kSEK (previous 330 kSEK)
2001: 330 kSEK
2002: 330 kSEK

Objectives: To communicate the programme, it's scientific and policy issues and the results of the ASTA programme to stakeholders. The communication should be directed to

a) make the programme and its goals known among scientists and stakeholders nationally and internationally,
b) give a deeper scientific understanding of the effects and their causes and control measures to all with an interest in transboundary air pollution,
c) ensure that the results from the ASTA programme will be known and considered in the policy-oriented work in Europe and elsewhere.
e) The communication project also includes the joint PhD activities within the ASTA programme.

The work within the information project includes the production of leaflets in Swedish and English, comprehensive yearly reports in Swedish and English and a running presentation of projects and results at the ASTA home page http://asta.ivl.se. Participation at conferences with posters and information material is also important in this context. The yearly report for 1999 was printed in Swedish and the report for 2000 in English. The report for 2001 will primarily be directed to Swedish stakeholders and include information of particular interest for these. It will probably be published in both Swedish and English. The reports are also available on the homepage. A leaflet of the programme in English was printed in the autumn 2000 and has been widely distributed. It was brought to the acid rain conference in Japan in December 2000, at which the ASTA programme was presented with one poster describing the overall programme and a number of scientific presentations.

The information strategy of the ASTA programme can also be viewed from a more general perspective. The whole programme has the aim to interact with the international community of scientists, experts and negotiators within the process of development of abatement strategies for transboundary air pollution in Europe. The exchange of information between all parts of the ASTA programme and its international context is one of the keys to success. All the work within ASTA has strong connections to the CLRTAP system and the EU CAFÉ initiative and we deliver and will continue to deliver results to these for inclusion in the ongoing scientific and policy process. ASTA scientists participate regularly in working groups, task forces and expert meetings.

Also, the exchange of information with various national stakeholders, including authorities, industry and non-governmental organisations, is important, both for the development and success of the programme and in order to get the programme results implemented in the society. The ASTA programme has been presented at various seminars and meetings e.g. at the Ministry of Environment, the Swedish Environmental Protection Agency and Elforsk.

The workshops and seminars held under ASTA are important instruments for the exchange of information. The more concrete activities mentioned in the section above only constitute the most directly visible parts of the information flow from ASTA. Several of the senior scientists within the ASTA programme are experienced in the field of communicating scientific results to a broader audience, outside the scientific community, and continuously participate in such activities.

The programme takes advantage of other organisations and their channels for the dissemination of the results, e.g. the Swedish Environmental Protection Agency and IVL for information to national organisations and companies, and the NGO Secretariat on Acid Rain and EU channels for the information to an international public. There are frequent contacts with the head of the NGO Secretariat (Christer Ågren) and participants in the programme.

Within the scientific community, the ASTA programme will play an important role in that it includes a number of PhD students. At present eight PhD students are active within the programme. Starting in the autumn 2000 ASTA is organising a number of short-term multidisciplinary, problem-oriented courses covering subjects relevant to the programme, which will be open also to PhD students outside the programme. Scientists within and outside the ASTA programme will be used as teachers and the students will be given relevant projects to work with as part of the course. The course will contain both a theoretical literature based part and practically oriented projects.

D3 Economic administration of the ASTA programme

Project leader: Peringe Grennfelt, Swedish Environmental Research Institute IVL, Göteborg
Budget 2000: 100 kSEK
2001: 100 kSEK
2002: 100 kSEK

Objective: To conduct the economic administration of ASTA programme, including the establishment of contracts with the founders and the participants, the follow-up of the economic transactions and the creation of economic reports to the founders and the steering board for ASTA.

Reports: Economic reports to the founders and to the steering board of ASTA.

Budget

The budget of the ASTA programme has increased during the programme and amounts in total for the period 2000-2002 to almost 30 MSEK. During 2001 the Swedish National Energy Adminstration gave an additional support of 500 kSEK per year for 2001 and 2002. This support included also a transfer of some ongoing activities so closely related to the ASTA A2 programme that both should benefit from a merge. (Table 2). Most of the additional support has been allocated to sub-programme A2, but parts of it can be allocated to other projects, primarily to A1:2 and C1:2. Decisions on allocation will be taken by the sub-programme's reference group.

The revised budget for the programme activities is presented in Table 3.

Table 2. Distribution of financial supports for 2000-2002.

Funding organisations	**kSEK**
Mistra	22 000
Elforsk, the National Board of Forestry and the Swedish National Energy Administration	5 600
Department of Environment/The Environment Protection Agency (IVL co-funded research)	2 236
Sum	***29 836***

Table 3. Budgets for the different sub-programmes of ASTA.

	Activity	Budget 2000-2002 kSEK (Nov 1999)	Budget 2000-2002 (Rev. Dec. 2000)	Budget 2000-2002 Revised Nov 2001	Annual budget for 2002
A1:1	International centre	4 500	3 300	3 250	1 200
A1:2	Integrated assessment	2 500	2 050	2 050	925
A2	National strategies	3 000	2 600	4 336	1 943
B	Social science	2 700	2 700	2 700	900
C1:1	Acidification – roof experiment	3 000	2 700	2 700	900
C1:2	Acidification – modelling	3 600	3 600	3 600	1 200
C2:1	Nitrogen – ecophysiology	1 500	1 500	1 500	500
C2:2	Nitrogen – vegetation processes	1 500	1 500	1 500	500
C2:3	Nitrogen –species dynamics	1 500	1 500	1 500	500
C3	Ground-level ozone	1 200	1 200	1 200	400
C4	Atmospheric chemistry – particles	2 400	2 400	2 400	800
D1	Scientific co-ordination	1 700	1 710	1 710	570
D2	Information	1 000	890	890	330
D3	Economic administration	300	300	300	100
	Reserve, unplanned	600	200	150	150
Sum		***31 000***	***28 150***	***29 836***	***10 918***

The increased budget will be discussed at a meeting with the reference group of A2. Some amounts may after that be allocated to other projects, primarily A1 and C1:2.

A1 Integrated assessment modelling and an International Centre for Evaluation and Assessment

A1:1 International Centre for Evaluation and Assessment

Principal investigator: Peringe Grennfelt, Swedish Environmental Research Institute

Budget: 2000: 900 kSEK
2001: 1200 kSEK
2002: 1200 kSEK

Goal: To evaluate and assess the overall achievements and needs for the future development of international abatement strategies.

Scientific approach and realisation: The *ASTA Centre for evaluation and assessment* is forming its activities in close collaboration with the ASTA board. The secretariat is located at The Swedish Environmental Research Institute. The work is mainly directed towards the direct needs of the international community and the topics depend on the international needs as well as the topics of the research within ASTA. A close collaboration is established with the Nordic Council of Ministers, and several projects are run in close collaboration.

Ongoing and planned activities

The recovery of forest soils and ecosystems in Europe - the perspective of present protocols and directives. Assessment reports and workshops. The use of critical loads for abatement strategies does not take into account the actual situation in different ecosystems. For the evaluation of the benefits of the control of sulphur and nitrogen, it is of crucial importance to find a method by which the actual situation and recovery of acidified systems can be included. ASTA has taken the responsibility of organising workshops to ensure that various models and methods for the assessment of recovery are tested and discussed and that relevant methods are to be used for European-wide assessments. The project is run in close collaboration with C1 and with the European network on forest conditions and the Co-ordination Centre for Effects under the CLRTAP. Two workshops have so far been held in Sweden; one in October 2000 and the other in October 2001. A third workshop is planned for the autumn 2002.

Budget 2000 100 kSEK
2001 100 kSEK
2002 100 kSEK

Nitrogen in forest ecosystems. A national meeting together with the Sufor programme on nitrogen effects and biodiversity will take place in December 2001. This activity will involve expertise from the ASTA activities A1:2, A2 and C2. The earlier planned evaluation and international workshop has been cancelled at present due to the large amount of activities already at hand (International Conference in the US October 2001 and the workshop on critical loads for nitrogen in Switzerland in 2002.

Budget 2001 70 kSEK

Develop and apply competence on the use of integrated assessment modelling with respect to Swedish national control measures.
The objective of this project is to develop competence on the application of integrated assessment modelling, in particular with respect to the introduction of control measures and their costs and the development of scenarios. The project is divided into two phases

1. compare the cost-effectiveness principles used in the Regional Acidification Information and Simulation model (RAINS) with the control measures proposed for meeting the Swedish environmental quality goals. This part of the project is finished and presented in a report and at the TFIAM in May 2001.
2. develop competence on building emission scenarios, in particular with respect to methods not so far included in the RAINS model. Scenarios will be focused for Sweden and be developed in close collaboration with IIASA. The intention is twofold; a) to develop scenarios for calculations within the A2 programme and b) to get an insight of the possibilities for including a wider set of control measures at the coming negotiations.

Budget part ii 2001/02 400 kSEK

Evaluation of the outcome of present control measures in Europe in terms of environmental quality. The objective is to analyse the outcome of present emission reductions in Europe in terms of changes in concentrations and deposition based on the EMEP data. There are results indicating that there are substantial non-linearities affecting the outcome of the control measures. The project is run in close collaboration with the CLRTAP Task Force on Measurements and Modelling. The theme is divided into sub-areas such as acidification, eutrophication etc. Collaboration is established with CCC and MSC-W under the LRTAP Convention and with many countries. .

Budget 2000 100 kSEK
2001 250 kSEK
2002 250 kSEK

Evaluation of data for critical levels for ozone level 2 and the organisation of a workshop in November 2002.
Budget 250 kSEK

The objective of the project is to evaluate data for the formation of a basis for mapping critical levels and estimate benefits of ozone control based on the so called Level II approach. The project includes preparation of background material, organisation of the workshop and a workshop report.

Current critical levels for ozone effects to vegetation have been developed through a series of UN ECE workshops; the first one at Bad Harzburg in 1988 and the latest in Gerzensee in 1999. Current critical levels are defined using a so-called Level I approach which means that they can be used to evaluate the potential risk to vegetation. However to quantify the impacts of ozone in a more detailed way including economic consequences there is a need for a more advanced approach – Level II. This approach is directed to quantification of ozone uptake and takes into account modifying factors such as climate, differences in tolerance between species etc.

The project is co-financed by the Swedish Environmental Protection Agency and the Nordic Council of Ministers.

Robustness and uncertainties of the tools and results supporting international assessment modelling – how to improve the quality?

Budget 200 kSEK

The objective of this project is a) to evaluate the robustness and uncertainties in the scientific data and models used for the Gothenburg Protocol and the NEC Directive and b) to evaluate to what extent the chosen approaches and assumptions are in line with the overall expectations in the agreements.

In January 2002, there will be a workshop on uncertainties at IIASA. ASTA will participate with two presentations; one on uncertainties on mapping critical loads and their exceedances (Alveteg and Sverdrup) and one on the overall needs and approaches (Grennfelt and Sverdrup). The activity should be seen as an introduction to the activities under phase 2.

Workshop on emission data quality and validation
Budget 200 kSEK

The aim of this project is to highlight the needs for validation and verification of air pollution emission inventories in Europe. The work will focus on a workshop that will be organised in collaboration with the Task Force on Emission Inventories and Projections (TFEIP).

Emission data play a crucial role in the development of air pollution control strategies in Europe and lack in quality may affect both cost curves and source receptor relationships. Both factors are important for the abatement strategies. TFEIP has so far done a comprehensive work on the preparation of guidebooks for the emission inventories but until now issues related to validation and verification have been given less priority. This workshop has the intention to start a process within the Task Force to develop methodologies and discuss results on verification and validation.

The project will also receive support from the Swedish Environmental Protection Agency and a proposal for support is submitted to the Nordic Council of Ministers.

Synthesis report
Budget 250 kSEK

The objective is to prepare a synthesis report on future strategies for the control of transboundary air pollution in Europe. The repost will be based on the achievements reached within ASTA and involve all sub-programmes. The report will cover some of the main themes in the ASTA programme such as the inclusion of dynamic aspects in the assessment of effects (critical loads and levels) and in abatements strategies, new directions on the assessment of effects from nitrogen deposition, the inclusion of forest production and other factors in the strategies.

The report will be prepared before the evaluation of the ASTA programme in May 2002.

New concepts and approaches for the control strategies to be used at the re-negotiations of the Gothenburg Protocol and the NEC Directive. (tentative)
The objective of this project is to propose and discuss new concepts and approaches for the further use of cost-integrated assessment modelling for regional air pollution control in Europe.

Deliverables from A1:1: Within the sub-programme, the aim is to deliver at least two international assessment reports per year and organise two international workshops.

Reference groups: For those activities under A1:1, where international co-ordination is a major concern, reference groups or scientific advisory groups will be formed.

Table 4. Status of projects in A1:1. (kSEK). The table contains all projects under A1:1 for the period 2000-2002. The total available amount of money for the period is 3300 kSEK.

Activity	Decided	Planned	
1. Saltsjöbaden workshop	250		Finished and reported
2. Recovery of forest soils	200	100	Two expert meetings. A third is planned to 2002. Decided 2001-11-26
3. Swedish seminar on nitrogen	70		Dec. 01.
4. Cost curves in the RAINS model	200		Finished and reported
5. The outcome of present control strategies EMEP evaluations	500		Running
6. Swedish national control measures after 2010	400		Running
7. Ozone workshop Nov 2002 and evaluation of ozone data	150	100	Decided 2001-08-23 and 2001-11-26
8. Robustness and uncertainties. IIASA workshop		200	Decided 2001-11-26
9. Validation of emission inventories		200	Decided 2001-11-26
10. Synthesis report		250	Decided 2001-11-26
Secretariat	300		Decided
Sum:	2070	850	
Sum decided + planned		2920	
Not decided or proposed		380	
		3300	

A1:2 Integrated assessment modelling

Principal investigator: Harald Sverdrup, Lund University
Project participants: Veronika Bergkvist, IVL

Budget: 2000: 200 kSEK
2001: 925 kSEK
2002: 925 kSEK

Goal: To develop model tools for dynamic aspects of environmental effects and for the analysis of benefits of the outcome of emission reductions in Europe *and especially to develop improved model descriptions of environmental effects associated with transboundary air pollution.*

Scientific approach and realisation: Integrated assessment modelling (IAM) is expected to play a crucial role in the development of future control strategies for transboundary air pollution in Europe. The problem has, however, several aspects of interest for future research; the model structure itself, policy goals and implementation, data improvement and expansion e.g. on effect criteria or cost functions etc. The ASTA Board decided at an early stage that its contribution in this area should be complementary to the international IAM activities in particular the model work at the International Institute for Applied Systems Analysis (IIASA).

Due to the uncertainty with respect to direction of research, a pre-project was run in 1999. The project, led by Mike Chadwick, involved a workshop in Sweden and the results were put together in a report (Chadwick 1999). The conclusions of the workshop was that the IAM aspects of the ASTA programme should focus on effect-related issues and how new aspects on effects should be implemented in the next generation of integrated assessment models.

The project described here will focus on the inclusion of dynamic aspects in the future integrated assessment models and on the linkage from IAM to assessment of benefits of control measures. The long-term objective is to develop model tools for environmental effects such as acidification of soils and waters, eutrophication of terrestrial ecosystems and ozone effects to crops and forests. In addition, the tools should also be capable of handling possible climate changes in terms of increased temperatures and changed precipitation patterns.

New results on the dynamic aspects of acidification, eutrophication and ozone are now available and can be used for the development of effect assessment tools including benefits integrated over time.

The work will performed as a cooperation between the University at Lund and IVL. An important link is also the IIASA group working on Integrated Assessment Models. The project will rely to a large extent on the basic scientific outcome of the C1, C2 and C3 sub-programmes. It will also work in close collaboration with the A1:1, A2 and B projects. International contacts will be established with different groups working on economic assessment of the effects of air pollution, especially groups in United Kingdom and Norway.

Workplan: The main project task is to provide effect modules which can be linked to or completely incorporated into the RAINS modelling system. This includes both initial work with existing models for ecosystem impact of air pollutants (MAGIC, SAFE, FORSAFE) and

development on new modules specifically designed for inclusion into the RAINS model system.
The priority of the work is:

1. **Effects of acid deposition on surface water chemistry and fish survival.** This includes work connected to the regionalisation of surface water effects of acidification which is the focus of the C1:2 project. In C1:2, the MAGIC model is used to describe acidification and recovery of forest soils and surface waters including a simplified description of fish survival. Based on the outcome of these results, a simplified generic module for recovery surface waters and effects on fish survival suitable for coupling to the IAASA Rains model will be developed. The work on effects of surface water acidification will initially be based on model results obtained from the MAGIC and SAFE models used in the C1:2 program. Furthermore, the results from the simulations will be *compared* to a model based to the Brown-Baker-Schoefield concepts for aquatic response, augmented with empirical data from NIVA (Skjelkvåle group at NIVA, Norge) and *national databases*. The final application of such a system will probably require some type of adaptation of the RAINS database, and will need to include both data on critical loads and the databases with the original data for their derivation. The need for additional data will be carefully adressed as data input must be minimized. Conclusions from and results presented at the Ystad expert panel meeting on dynamic modelling will be used in this task. This work was initiated in 2001 and will be completed in 2002.
2. **Coupled S, N, C module** (FORSAFE) for effects of forest growth and links to climate change. Performed in coordination with SUFOR and the A2 program. Within the A1:2 subprogram, work will focus on the development of the effect parameterisation of the coupled model. This work will be initiated and partly completed in 2002.
3. Prepare for development of an integrated model for the effects of chemistry, nitrogen, temperature, moisture and competitative aspects of ground vegetation biodiversity. This work will be initiated in 2002 and an overall structure of the model will be developed. Further work and completion is planned for phase 2 of Asta.

Our intention is to establish a permanent model development workshop under the framework of the ASTA programme and in close collaboration with SUFOR. The workshop will consist of Profs. H. Sverdrup (A1) and P. Warfvinge (C1:2), Dr. M. Alveteg (C1:2), C. Axelsson (A2), L. Martinson (C1:2) at the Lund University and Prof. Peringe Grennfelt, Drs. Filip Moldan and John Munthe and Olle Westling at IVL. Under A1:2

Assessments will be started already with the first model versions, in order to address usefulness, ease of operation and performance. The tool will be developed and tested at home (Nordic countries), then tested on the best effects data abroad (Europe) and then used in collaborative projects (Germany, Switzerland).

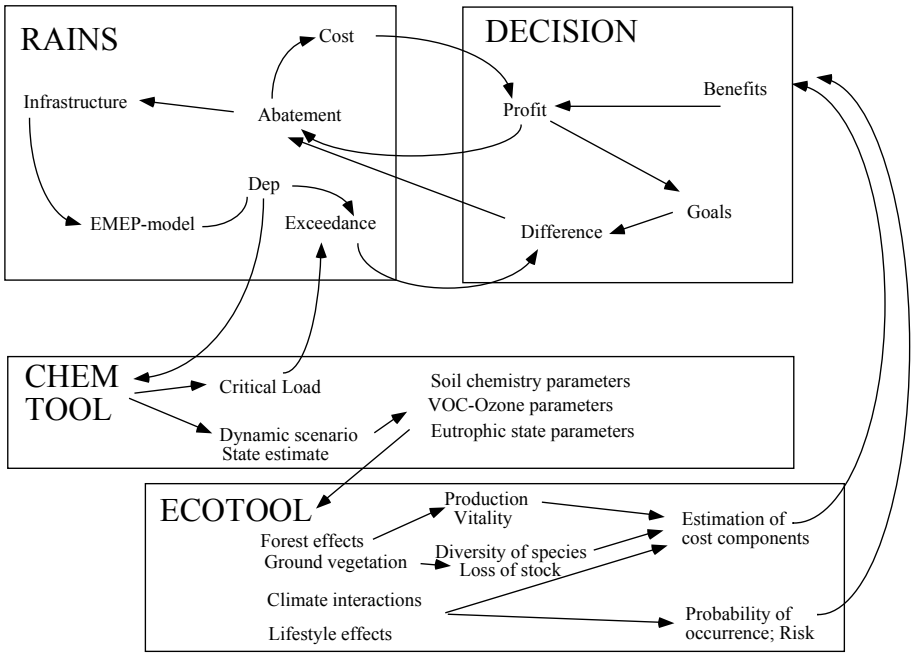


Fig. 1. A schematic overview of the new assessment model developed from RAINS. Our goal is primarily to build the ECOTOOL module and in Cupertino with the de Vries group at Alterra Institute (Wageningen, Netherlands) to develop the CHEM-TOOL model

A2 National strategies for emission control and land use – a national platform

Project description 2000 to 2002

Principal investigator: Olle Westling, IVL
Participants: Cecilia Axelsson and Mattias Alveteg, LuTH; Filip Moldan, IVL

Budget:

2000:	450 kSEK
2001:	1 943 kSEK
2002:	1 943 kSEK
Totalt	4 336 kSEK

Goal: To develop tools for optimisation of national abatement strategies for nitrogen and acidifying components with the focus on areas where transboundary air pollution and forestry and other land-use practices contribute to environmental effects.

Scientific approach and realisation: The work towards national environmental targets concerning forest soil acidification and nutrient status/productivity requires tools that can be used for identification of potential abatement strategies as well as for scenario analysis and evaluation. Potential control measures include emission reductions in Europe and adaptation of national land-use including forestry practices.

Within the ASTA programme, model tools will be developed with the focus on ecosystem effects caused by deposition of acidifying compounds. Specific efforts will be made on different effect criteria for critical loads and dynamic modelling of forest soil recovery. The different ASTA projects will interact to ensure that any model tools developed will relevant for both national and international applications. Specifically, this project will be integrated with the A1:2 project focussing on the development of integrated modelling tools and effect models for international applications. Within the national platform, model applications will be developed focusing on areas where transboundary air pollution and land-use contribute significantly. Strategies for sustainable land use including forestry for biofuel production and wood-ash recycling will be examined.

The programme will focus on the following two topics:

- *Nitrogen budget in forest soils.* Availability of nitrogen is a limiting factor for forest production but excessive anthropogenic contributions of nitrogen will also increase risks for eutrophication, acidification and leakage to ground- and surface waters. The work on nitrogen fluxes with simple mass balance models in relation to forestry practices was initiated in 2000 and will be completed in 2002.
- *Acidity and base cation budgets in forest soils.* Sustainable forestry requires that the soil is not acidified by depletion of exchangeable cations (lowered base saturation). In areas with significant soil acidification, recovery of soil status is also a requirement. With present knowledge, it is not possible to identify areas where further adaptation of forestry practices including fertilisation is necessary.

The main questions for the A2 programme is:

- Will planned emission reductions in Europe lead to a permanent improvement of the environmental status in Sweden, and which effects are critical?
- Can environmental targets for land-use and atmospheric deposition be realised simultaneously, and which are the potential conflicts?
- What is the potential for biomass production and harvest in areas impacted by air pollution with a perspective of sustainable forestry (growth, hydrology, nutrient availability, acidification and recovery) taking into account possibilities for wood ash recycling or other compensatory measures?

Workplan: A detailed work plan has been prepared for the period 2000 to 2005 in co-operation with the A2 reference group. The project contains the following main tasks:

1. Model framework design. This activity includes development of a model system framework with all major components of the final modelling tool represented in simplified versions. This model framework will be used to perform initial testing and for identification of priorities for the following stages of the project. Status: Completed in 2001

2. Mapping of national land use and emissions. The objectives of this activity will be achieved in collaboration with the Mistra RESE programme. Status: Completed in 2001.

3. Data assimilation and evaluation. This activity includes information on critical limits, soil status/composition, forestry scenarios, emission/deposition scenarios. During 2002, the developed GIS maps will be complemented with relevant data on soil status, vegetation, deposition, etc. to allow modelling of forest soil acidification and recovery.

4. Application of biogeochemical models. This activity will mainly rely on dynamic models for acidification and nitrogen cycling developed within other sub-projects of ASTA. A close collaboration with the SUFOR programme is established which will allow the use of model tools and data based generated within that programme. Dynamic models developed in LUSTRA (cycling of nitrogen/carbon) will also be used. This work was commenced during 2001 and will continue in 2002. Initially, several different models will be employed for different applications:

> **MAGIC and SAFE** for recovery of acidified forest soils and surface waters at different deposition and forestry practice scenarios
> **COUP** for nitrogen and carbon cycling
> **FORSAFE** for integrated S, N and C modelling and links to climatic factors and vegetation/biodiversity

Of the above model steps, the work on forest soil acidification (MAGIC and SAFE) is anticipated to be finalised in 2002 whereas an assessment of the FORSAFE model will be made. Further work on the FORSAFE model is planned for phase II of ASTA.

5. Indicators. Parameters, which can be used as integrative indicators for sustainable forest soil use, will be developed and employed. Examples of potential indicators are: C/N ratio > 25 in the humus layer; nitrogen accumulations < 1 kg /ha yr.; nitrogen leaching during clear-cutting < 10% of total area loss during forest lifetime; limiting values for acidification parameters in stream water (pH, ANC, inorganic aluminium, etc.). This work will be initiated in 2002.

6. Effects of tree species and whole tree harvesting on soil acidification and turnover of nutrients in soil. ASTA A2 will take over one subproject with closely related research from a

project at IVL focused on measures to counteract acidification of forest soils in the south part of Sweden. The subprojects comprise field studies of effects on soil and soil water of harvest and other management methods in deciduous forests and also slash removal in old experiments with pine on poor soils.

By combining the results from task 1-6, feasible control strategies and land-use scenarios can be developed and tested in an integrated assessment. The system for assessment of control strategies should be compatible with tools for analysis of cost/benefit. Initially, the project will focus on case studies of regions where sufficient information is available.

Reference group: For A2 a reference group has been formed consisting of the following persons: Gunnar Hovsenius (Elforsk), Anna Lundborg (Energimyndigheten), Håkan Staaf (Naturvårdsverket), Göran Örlander (Skogsstyrelsen), Mats Olsson (SLU, representing the Mistra programme LUSTRA), Bengt Nihlgård (Lund University, representing the Mistra programme SUFOR) and Peringe Grennfelt/John Munthe (IVL, representing ASTA). The reference group will support the setting and revising of priorities of the activities within A2, advice on how the model system can answer the relevant questions of A2, advice on the choice and development of models and help identifying available sources of data or need for further data collection.

B Scientific Processes behind Abatement Strategies – A Social Science Perspective

Principal investigator: Göran Sundqvist, Göteborg University
Partner: Rolf Lidskog, Göteborg University, PhD-student Martin Letell, Göteborg University

Budget: 2000: 900 kSEK
2001: 900 kSEK
2002: 900 kSEK

Goal: The objective of this sub-programme is to analyse and evaluate the link between scientific research and policy decisions within the field of transboundary air pollution. The programme will contribute to the understanding of the interplay between science and policy and the links between international and national processes. Thereby it will be possible to assess what defines a scientific credible and political legitimate, i.e. an effective, science/policy relationship within an environmental regime (CLRTAP).

Scientific approach and realisation:
The sub-programme focuses mainly on the issue on how scientific consensus for international agreements is formed. The theoretical aim is to improve the understanding of the consensual character of scientific practice, how scientists in policy-relevant situations as experts produce agreed knowledge and how they handle uncertainties, ambiguities and controversies. The overall question is therefore to analyse how consensus is reached in scientific policy-relevant practice and what importance consensus among scientists has for building credible environmental abatement strategies. Evaluations of international regimes have pointed out the importance to balance scientific credibility and political legitimacy. Scientific credibility means that policy is based on certified knowledge, that scientists have been closely involved in the negotiations and that the scientific community is satisfied with the content of knowledge on which the regime is based. Political legitimacy, on the other hand, means that all parties involved – politicians, NGOs and citizens in the signing countries – consider the regime to be important, transparent, understandable and fair. To achieve a regime that is considered as both scientifically credible and politically legitimate means that the two worlds of science and policy need to be balanced in a suitable way.

Our assessment is that the relationship between science and policy to a large extent is misconceived, not least by social scientists. A first step has been to evaluate and criticise the dominant understanding of this relationship held by political scientists. Most of the research on the role of science in environmental policy-making have been conducted by political scientists. To a large extent this research has taken scientific results for granted, as "black-boxed" inputs to policy negotiations, at the same time as it has proposed that scientific results have been of great importance in the policy-making process. In a paper, we propose an alternative understanding of the science-policy relationship – i.e. that knowledge never moves freely, that the value of science is the result of negotiations, and that science and policy are co-produced. The relevance and explanatory power of this approach is illustrated by a case study of the LRTAP Convention. By way of conclusion, it is stated that science has no strength in itself but is given strength by different institutions and actors, and this has to be explained by social scientists. The paper will be published in early 2002 by the European Journal of International Relations (European Consortium for Political Research), which are

the leading European-based journal discussing international policy-making (Lidskog & Sundqvist 2002).

The next step has been to use the proposed approach in an analysis of the meaning and usage of the critical loads concept in the LRTAP-context: on how different actors rhetorically have used the concept. The conclusion is that the concept has been used as a "boundary-object" which has made possible a close contact between scientists and policy-makers, however at the same time allowing different – sometimes competing – interpretations of the scientific status of the concept. The concept has been plastic enough to allow different conceptions and at the same time serve as an instrument of integrating different actors (Sundqvist, Letell & Lidskog 2002).

In the year 2002 we will publish work on three different topics:

i) Consensus, uncertainty and credibility. The formation of a commonly accepted body of data, analyses and scientific understanding means a narrowing of uncertainty and thereby putting pressure on negotiators and political representatives to find political solutions. Within the LRTAP-context, science has through a number of means worked to create consensus among scientists, thereby speaking with a unanimous voice. However, consensus has many times been hard to achieve, and has been reached by a too far-reaching reduction of complexity. Therefore, recent strands in science studies have suggested that scientific credibility should replace the goal of consensus. In a paper we will discuss the political implications of replacing scientific consensus by scientific credibility in the LRTAP-work.

ii) In a historical study it is studied how the concept of *transboundary* air pollution, in a way similar to that of critical loads, rhetorically connects the domains of facts and values. The study also indicates that the Scandinavian "persuasion process" of the 1970's involved concrete material aspects such as standardisation of monitoring methods.

iii) In a study the policy implications of the concept of recovery is focused upon. In interviews with natural scientists they are asked to reflect on the policy implications of their work. This study is aimed to closer involve the natural scientists of the ASTA programme in the social science programme.

C1 Acidification

Sub-programme co-ordinator: Mattias Alveteg, Lund University

C1:1 Recovery from acidification - Experimental reversal of acidification in the roofed catchment and biogeochemical processes

Principal investigator: Filip Moldan, Swedish Environmental Research Institute

Budget: 2000: 1000 kSEK
2001: 900 kSEK (previous 1000 kSEK)
2002: 900 kSEK (previous 1000 kSEK)

Goals:
1. To monitor and evaluate the biogeochemical recovery in a covered catchment
2. To quantify the relative importance of sorption processes compared to organic sulphur cycling, during the process of acidification reversal in a covered catchment and in a control catchment.

Scientific approach and realisation:
During the summer 2001, the covered catchment project went into its third and final phase when the plastic cover of the roof was taken away. The catchment will now be studied for two years without roof in order to investigate the possible interferences from the roof itself. To address the question of experimental artefacts is of importance for generalisation of the results measured at Gårdsjön. In addition, the removal of the roof will cause yet another abrupt deposition change. The complexity of measured trends in soil and runoff chemistry is therefore likely to increase. That will present yet another challenge to the geochemical models.

Many of questions asked in the beginning of the Covered Catchment Experiment (CCE) have now been answered. Deposition reduction at the ROOF was followed by a rapid and strong improvement of the runoff water quality. At the same time, however, no major improvement was observed in parameters commonly used to indicate tree vitality (crown density and discoloration, tree growth, fine roots, mycorrhiza), water quality related to fish toxicity and soil base saturation. Sulphur dynamics in the soil and sulphate desorption in particular has been identified as a crucial factor, which largely controls runoff chemistry for a certain time after the deposition has decreased. The project is now entering an intense phase of evaluations in order to draw as valid conclusions as possible. The question still remain if the project will be able to quantitatively answer some of the questions regarding long term effects e.g. the importance of mineralisation of organic sulphur.

A repeated soil investigation has been performed and soil samples were taken in a grid over the whole catchment before the roof was constructed in 1990. The soils were re-surveyed in 1995 and most recently in 2001 (financially supported by NV). Results are expected to be available in late 2001 and will be evaluated during 2002.

An effect-oriented investigation of the biological recovery is planned. This includes repeated survey of tree health measured by tree growth, canopy discoloration, state of fine roots and mycorrhiza as well as repeated fish toxicity test of runoff water, last performed in 1992.

However, the biology investigation is to a large extent dependent on external financing outside the ASTA program, which is to date approved only to an extent.

The sub-programme is run in close collaboration with the modelling activity under C1:2 and also in collaboration with A1 and A2. Collaboration with other groups in Europe running similar experiments is already at hand, primarily through an EU programme on recovery, in which we are participating. The experiment is also important as a basis for information about the problem of transboundary air pollution and the research activities.

C1:2 Tools for modelling the recovery of forest soils and surface waters from acidification

Principal investigator: Mattias Alveteg, Lund University
Partners: Filip Moldan, IVL and Kevin Bishop, SLU

Budget: 2000: 1 200 kSEK
2001: 1 200 kSEK
2002: 1 200 kSEK

Goal: The overall goal is to assess spatial and temporal aspects of recovery of forest soils and aquatic ecosystems from acidification, by means of mathematical biogeochemical modelling that makes use of the extensive environmental monitoring data available in Sweden. The assessment should provide input to the CLRTAP activities to develop cost-efficient emission reduction strategies that account for the dynamics of ecosystem recovery.

Scientific approach and realization:
The methodology rests on two foundations:
- Mathematical biogeochemical models that account for the dynamics of aquatic and terrestrial ecosystem response to reduced acid deposition.
- National environmental monitoring data that support the model assessments of the regional dynamics of acidification recovery.

The outcome of the workshop on critical loads in Copenhagen November 1999, where the ASTA programme made an important contribution (see A1:1), will provide an important basis for this work. Of importance for the overall inclusion of the dynamic aspects into critical loads mapping and assessments are also the two international expert workshops in 2000 and 2001 (see A1.1 project 1).

In this project, different deposition scenarios supplied by IIASA will be used in a regional dynamic application of the SAFE model to Sweden, as well as in collaboration with other countries and research groups, in order to assess the ecosystem response to different abatement strategies. Furthermore, the dynamic model MAGIC will be used to make a regional dynamic assessment of stream water chemistry in Sweden, using different deposition scenarios. The results should be used to assess the benefit of present control strategies and form a basis for future control strategies.

An important asset in regionalized predictions of acidification recovery is the extensive documentation provided by national environmental monitoring programmes of how Swedish ecosystems has been responding to a decade of sustained declines in acid deposition. During

the last few years, statistical analysis of environmental monitoring data has shown significantly reduced SO_4^{2-}-levels in a number of Scandinavian surface waters as a result of decreased acid deposition. The improvement in surface water quality in response to decreased emission/deposition has important implications, both scientifically and politically, for future abatement work, which should be capitalised on in ASTA. This involves reporting what has happened and the observed response as validation data for the reliability of the modelling tools applied to the question of predicting recovery from acidification. Co-ordinated analyses of surface water monitoring data by means of statistical and model tools are surprisingly uncommon in the literature. Given the extensive national investment of surface water, soil and forest monitoring, Sweden is well positioned to complement this modelling project with extensive observations.

Year 2000:
Evaluation of a pre-study on a regional Swedish assessment of soil chemistry dynamics using the SAFE and MAKEDEP models. Refinement of the set-up and of the models, reapplication.

Applying the MAGIC model with sulphate adsorption to the 10 years of data from the Gårdsjön covered catchment to explore the importance of sulphate adsorption. .

Preparation of 15 more detailed catchment data sets from national monitoring data which will be used for modelling and model evaluation.

Developing methods to include dynamic aspects of acidification/recovery in abatement strategies.

Incorporating simplified sulphate adsorption submodel in the SAFE model.

Year 2001:
Applying the new SAFE model with sulphate adsorption to the 10 years of data from the Gårdsjön covered catchment to explore the importance of sulphate adsorption. This will include refined measurements of the characteristics of sulphate adsorption at Gårdsjön.

Incoporating nutrient content elasticity in the MAKEDEP model.

Scenario analysis on selected forest sites using SAFE/MAKEDEP.

Further development of regional model setup with MAKEDEP/SAFE including assembling updated database with 700 Swedish forest sites. Regional assessment of forest soil chemistry dynamics using MAKEDEP/SAFE.

Application of MAGIC to detailed catchment data sets.

Statistical analysis of the small catchment data.

Magic modeling of small catchment data (done for two catchments and in press).

Use of paleoecological data to calibrate the first MAGIC applications to lakes in Northern Sweden.

Assesment of recovery trends in intensely monitored small catchments in Scandinavia.

Year 2002:
Magic Modeling of the remaining detailed catchment data sets.

Acidification Assessment of Status in Sweden using the national lake survey and NV's Environmental Quality Criteria.

Application of SAFE and MAGIC to the detailed catchment data sets and to a selection of lakes using national databases.

Regional scenario analysis using the SAFE and MAGIC models.

Evaluation of developed methods for including dynamic aspects in abatement strategies: Calculating isolines of partial ecosystem recovery for selected Swedish forests and future emission scenarios from IIASA.

Evaluation of regional response to the response in 100-200 reference lakes and water courses.

C2 Nitrogen induced ecosystem changes

Sub-programme co-ordinator: Torgny Näsholm, SLU, Umeå.
The objective of the sub-program me on nitrogen is to present new dose-response relations for nitrogen deposition to forest ecosystems. The studies will include both experimental studies with low nitrogen doses to background areas in the north of Sweden and interpretations of field observation studies all over Sweden.

The results will be linked to the models used and further developed in A1:2. The results will also be presented and further discussed at national workshops and at the international nitrogen conference in the US in the autumn 2001.

C2:1 Nitrogen dose and nitrogen form - ecophysiological responses

Principal investigator: Torgny Näsholm, SLU, Umeå.
Budget: 2000: 500 kSEK
2001: 500 kSEK
2002: 500 kSEK

Goals: The goals for this activity are**:**

1. to evaluate the importance of qualitative changes in nitrogen availability imposed by nitrogen deposition for vegetation changes,
2. to characterise nitrogen induced biochemical changes of importance for natural enemies in ericaceous plants, and
3. to identify indicators and criteria for assessment of effects of nitrogen deposition on natural and semi-natural ecosystems in order to define critical loads for nitrogen.

Scientific approach and realisation:
An ecophysiological approach is taken to study nitrogen effects on ground layer species in a coniferous forest. The scientific approach will be to perform experiments with different amounts and different forms of nitrogen in an area with low background deposition of nitrogen. These studies will provide information on the mechanisms behind nitrogen induced ecosystem changes which will be used to produce a conceptual model. Moreover, the studies will provide us with tools for studying systems affected by, or recovering from, nitrogen deposition, enabling us to assess the impact of nitrogen on these systems.

In the proposed activity, primary responses to increased nitrogen availability are studied and mechanisms behind changes in species assemblages will be identified. Our experiment differs from other nitrogen addition studies in that (i) the experiment is performed in an area with historically low input of nitrogen, (ii) the rates of nitrogen additions tested are low compared to most other studies, (iii) it involves nitrogen addition at different scales, (iv) it tests the importance of qualitative as well as quantitative changes in nitrogen supply, (v) it takes advantage of a close co-operation between plant physiology and plant ecology so that (vi) a range of biotic and abiotic interactions of potential importance for plant performance can be studied. Thus, in combination with Activity C2:2, the activity will provide new and original data, which can be used to derive dose-response relationships for nitrogen effects.

One central aspect of species changes following nitrogen input is uptake and usage of nitrogen in different plants. Species differ in their ability to take up and use nitrogen for growth. Such differences are both of a qualitative and a quantitative nature, i.e. species

competitiveness differ both between different nitrogen forms and different amounts of nitrogen. Thus, deposition of nitrogen, which mainly occurs as nitrate and ammonium compounds, will not only increase nitrogen supply for plants but will also shift the supply towards increasing shares of inorganic nitrogen. This shift has not been identified as a major impact of nitrogen deposition earlier. Given the new information concerning the importance of organic nitrogen that is emerging, it is tempting to suggest that such qualitative changes might be of great importance in promoting vegetation changes. The current activity will compare uptake of different nitrogen forms in understorey species and try to relate this to the relative performance of different species in the field.

For ericaceous plants, like blueberry (*Vaccinium myrtillus*) or lingonberry (*V. vitis-idaea*), attacks of natural enemies has the potential of disturbing, or even killing plants over large areas. Important natural enemies for blueberry and lingonberry are butterfly larvae and parasitic fungi. Information on how increased nitrogen supply interacts with the frequency of attacks of these enemies is therefore of fundamental importance for understanding nitrogen effects on vegetation. In the current proposal effort will be taken to identify the relevant biochemical alterations that promotes attacks of natural enemies. Identifying these substances serves two functions: (i) it helps to understand how nitrogen supply affects the interaction between a plant and its natural enemies and (ii) it provides tools to assess the risk for outbreaks of natural enemies in regions affected by nitrogen deposition. This latter achievement fits into the third objective stated above, i.e. finding indicators and criteria for assessing impact of nitrogen deposition on forest ecosystems.

We have established a series of nitrogen addition experiments in the county of Västerbotten, a region with very low levels of background deposition of nitrogen. All experiments are located in mature coniferous stands where the natural understorey is dominated by *Vaccinium* species but also with some herbs and grasses occurring sparsely. In these experiments, nitrogen is added to small plots at doses of 6; 12.5; 25 and 50 kg N ha^{-1} y^{-1} as ammonium nitrate; potassium nitrate or ammonium sulphate. These experiments will be complemented with an experiment comparing effects of organic and inorganic nitrogen additions. The added substances are labelled with a small amount of ^{15}N which enables the measurement of the uptake of different nitrogen sources in different compartments and in different species. Moreover, measurements of biochemical changes following addition of nitrogen will be taken. These include measurements of different nitrogen fractions (amino acids, soluble proteins) and different substances normally classified as "defence substances", i.e. phenolic acids, anthocyanins and tannins. We will also quantify ergosterol and chitin, two fungal markers, to assess fungal attack on leaves and stems. These markers will also be quantified on roots to give information on possible effects on mycorrhizal development.

Information collected from these experiments will be used to construct a conceptual model for nitrogen induced vegetation changes. From this, dose-response relationships will be derived. Moreover, indicators developed within the experiment will be tested in survey studies and in studies of stands earlier exposed to high rates of nitrogen supply (recovery studies). More precisely, we will measure both the incidence of attack of natural enemies and the biochemical changes that we have identified as critical for these attacks. These will be related to species assemblages and rates of nitrogen deposition in the stands. The primary object for these studies will be coniferous stands similar to those used in our experiments.

During the first year (2000), the intensive studies of our fertilisation experiments have continued. Studies relating to nitrogen uptake and nitrogen usage have to a great extent been

completed during this first phase. Also, studies of biochemical responses of vegetation following a sharp decrease in N input (recovery) has been performed. In the second phase of the project (2001-2002), increased emphasis will be put on studies of vegetation affected by N deposition. Thus, during this part of the project we will test to what extent the mechanisms that we have identified as critical for vegetation changes are operating in systems affected by N deposition. The output from the project will primarily be articles in scientific journals. Our aim is to publish 1-2 articles describing species differences in N uptake and 1-2 articles describing biochemical changes of plants following N additions. Studies of effects of decreased N input and of systems affected by N deposition will be published in co-operation with project C2:2 (se below).

C2:2 Nitrogen dose - vegetation responses

Principal investigator: Lars Ericson Umeå University, Umeå
Budget: 2000: 500 kSEK
2001: 500 kSEK
2002: 500 kSEK

Goals: The overall objective of this activity is

a) to clarify the biochemical mechanisms involved in the interactions between plants and their natural enemies,
b) to clarify the numerical response of the ground layer plants and their natural enemies,
c) to find suitable indicators for assessing nitrogen deposition effects upon vegetation and
d) to provide, in combination of results from Activity C2:1, new and original data on dose-response relationships for nitrogen induced ecosystem changes to forest ecosystems.

Scientific approach and realisation:
Of prime importance is to understand to what extent vegetation effects due to increased nitrogen deposition are scale-dependent. This information is a prerequisite to utilise existing data from various earlier investigations where effects of increased nitrogen deposition has been studied. The proposed study is performed in close co-operation with assoc. prof. Torgny Näsholm´s activity C2:1.

Earlier studies have indicated that herbivorous insects can play a crucial role in nitrogen induced vegetation changes. In the current activity we have focused on natural enemies that potentially can influence the vegetation in a similar manner as the heather beetle in the *Calluna*-system. The *Calluna*-systems have, however, been exposed to high levels of nitrogen deposition for several decades. In contrast, the proposed studies will be performed in an area with historically low nitrogen input. Thereby, initial responses of the biota to increased nitrogen input can be studied. We have been able to quantify a drastic increase in the abundance of natural enemies already at low levels of nitrogen supply and preliminary data indicates that these attacks have a measurable impact on species composition. We propose that the interaction between parasitic fungi, herbivorous insects and vegetation is an important factor regulating species assemblage in coniferous forests.

Earlier studies of nitrogen effects on vegetation have mostly used small sized plots for nitrogen additions. We have established an experiment testing nitrogen additions at different scales. Preliminary data from this experiment shows more extensive attacks of natural enemies in large plots than in small plots. These increased attacks are likely to lead to higher rates of vegetation changes in large than in small plots. Thus, results from this experiment

indicates that studies undertaken at smaller scales are likely to underestimate nitrogen deposition effects on vegetation

In natural, nitrogen limited ecosystems not only plants, but also their natural enemies are limited by nitrogen supply. However, whether a natural enemy will be able to build up high population densities depends not only upon food quality but also upon the scale under which an experiment is undertaken. This interaction between scale and dose/response is necessary to consider in order to understand if a herbivore or a parasitic fungus, or the interaction between them will have any dramatic effects upon species composition of the ground layer flora. Our ongoing experiments have already pointed out (i) a clear response among some natural enemies at low doses of nitrogen supply and (ii) a clear scale dependent effect after two years treatment where effects upon vegetation show marked differences.

Through the co-operation between this activity and the more physiological/biochemical oriented activity supervised by Torgny Näsholm, we will be able to search for simple indicators to be used in later stages of the activity. Results will also be used in future assessments of the risk for significant effects on species composition in ecosystems subject to nitrogen deposition. Finally the results will be used in the development of critical loads and in environmental monitoring. Biochemical markers, such as amino acid concentration of foliage (see above), will be necessary to consider.

We have established an experiment testing nitrogen additions at different scales. This experiment includes nitrogen doses of 12.5 and 50 kg N ha^{-1} y^{-1} as well as control plots. The plots are sized 1; 10; 100; 1000 and 5000 m^2 and the experiment is replicated 6 times. Moreover, we will use the experiments using small-sized plots described under activity C2:1. In both the scale-experiment and in the small plot experiments we monitor vegetation, score the occurrence of various natural enemies in particular parasitic fungi and herbivorous insects on ericaceous shrubs. This part of the work is time-consuming due to statistical demands. In this way, dose-response relationships between nitrogen additions and vegetation changes can be obtained. Moreover, the importance of natural enemies for these changes can be evaluated. As various natural enemies differ in their response, as well as their effects upon species composition of the vegetation, the work includes by necessity accurate determination of vegetation composition down to species level.

Intensive studies of our fertilisation experiments will be performed during the first part of the project. Gradually, studies will be shifted to objects were recovery aspects of vegetation can be followed and thereafter, ecosystems affected by N deposition will be the target for our investigations. The results from the studies described above will be published in international scientific journals. We aim to publish two articles describing the importance of biotic interactions for species replacement following increased inputs of N. In the following studies of recovery of vegetation after decreased rates of N input and of deposition effects on vegetation; our aim is to publish another two articles.

C2:3 Effects of nitrogen deposition in forest ecosystems on ground-layer species dynamics

Principal investigator: Ursula Falkengren-Grerup, Lund University

Budget: 2000: 500 kSEK
2001: 500 kSEK
2002: 500 kSEK

Goals: The aim of this activity is to use ground-layer species composition in deciduous, hardwood forests in Sweden as a dynamic measure in time and space of the response of forest ecosystems to nitrogen deposition. A dose-response function is established by relating observed vegetation changes to various nitrogen measures such as present nitrogen deposition, accumulated nitrogen deposition and nitrogen deposition relative to nitrogen mineralisation rates in the soil.

Scientific approach and realisation: A wide range of soils is included that differ in soil chemistry, vegetation and responsiveness to nitrogen. Extrapolation of results to other Nordic and European countries can thereby be tested and validated against existing data. The response of the vegetation is measured by use of nitrogen indices and changes in biodiversity, plant functional types (PTF) and indicator species (specialists). Effects of soil eutrophication and acidification on vegetation are considered separately as far as possible.

The effects of atmospheric nitrogen input are complex. Chronic nitrogen deposition may result in a surplus of nitrogen in comparison to other nutrients, the enhanced nitrogen inputs no longer stimulating plant growth but starting to disrupt ecosystem structure and function. In areas with lower deposition, nitrogen is mostly retained in the soil but leaching of nitrate occurs. Although effects on organisms probably start soon after changes occur they are seldom directly visible or measurable. Empirical values based on observed changes in the structure or function of ecosystems have been used to define critical loads (CL) for terrestrial and wetland ecosystems. A broad CL interval was chosen for most ecosystems due to few studies and inaccurate results and to lack of definition of the reference point in time from which an acceptable degree of change could be defined. (Further background is given in main proposal and its appendices.)

The work is based on 700 deciduous forest sites south of Limes Norrlandicus. To be supplemented is the number of sites in the heavily exposed provinces of Halland and Bohuslän that are present in too few numbers or have a skewed pH-distribution. The data have been used in earlier publications. Basic data are therefore available for soil chemistry, nitrogen mineralisation rates and vegetation structure and some correlative relationships between species occurrence and nitrogen deposition and nitrogen mineralisation are known. We have worked with plant responses to acidification and eutrophication on species level. Within the ASTA-programme (starting 2000) the data shall be used to calculate the varying dose-responses of ecosystems and their critical loads at defined changes in the vegetation.

A simple model is parameterised for soil chemistry and C:N ratio and the nitrogen dose is calculated in multiple ways including the most suitable of variables such as nitrogen mineralisation rate, current and accumulated nitrogen deposition and nitrate deposition (especially to non-nitrifying soils). The response variables are also tested in multiple ways to find suitable measures to be used over larger areas, e.g. species composition of the ground-layer, grouping in plant functional types and plant specialists that are clearly defined by a

nitrogen related parameter. Two indices can be used to calculate changes in species composition, namely our own FNIS-index and Ellenberg's N- values. Definition of relevant plant functional types is an important part of the project. They have to be established from the beginning to be specific for response to nitrogen. Likewise, the indicator species for nitrogen are to be calculated and defined as generalists and specialists. The specialists have a narrow distribution curve as related to nitrogen availability. The modelled vegetation change is then going to be validated against results obtained in retrospective studies and fertilisation experiments.

Year 2000:
Classification of species in groups of specialists-generalists in nitrogen utilisation based on Gauss curves
Classification of species in plant functional types
Supplementary analyses of vegetation and soil in 40 sites in Halland and Bohuslän followed by analysis of soil chemistry and potential net nitrogen mineralisation rates
Calculation of dose-response curves

Year 2001:
Finalising vegetation parameters to be used in a simple dose-response model
Running the model for different scenarios

Year 2002:
Running and validating the model for Swedish data
Testing the model for European data
Critical loads are set for ecosystems with varying vulnerability

C3 Ground level ozone

Principal investigators: Håkan Pleijel
Partner: Per Erik Karlsson, Swedish Environmental Research Institute, Göteborg
Budget: 2000: 400 kSEK
2001: 400 kSEK
2002: 400 kSEK

Goal: To develop a scientific basis for effect-based concepts and criteria to assess ozone effects to vegetation, to be used in the preparation of the next generation of transboundary air pollution strategies in Europe.

Scientific approach and realisation:
The general background is given in the original proposal of ASTA. At present, the work with quantification of ozone effects on vegetation is moving from a so-called Level I perspective to a Level II perspective. This means that the step is taken from a general risk assessment, which does not account for most dose- and response-modifying factors, to the inclusion of these factors with the aim of quantifying actual growth or yield loss or other effects due to ozone. Some of the most important factors to consider in the Level II perspective is ozone uptake by the stomata (in contrast to the concentration outside the plants used at Level I), phenological weighting (especially for crops; instead of the fixed time windows for broad plant categories and wide geographical regions) and the extrapolation from experiments to ecosystems (especially forests). The workshop in Gerzensee in April 1999 (see below) can be seen as the

starting point for the Level II developmental work concerning ozone effects on vegetation in Europe. A new workshop with the aim to take the Level II approach into assessments and integrated assessment modelling will be considered. In addition, the relevant results and scientific progress will be brought up in ICP forests and ICP vegetation (former ICP crops).

The work will be divided in two parts: crops and forest trees. The influence of the Nordic climate and ozone load (present and future according to models) will be in the focus of all activities.

A. *Crops.* The most important pieces of work to be made by our group within the ASTA programme are:
1. The development of a flux-response relationship for potato (a plant for which sufficient information exists) this goal has been achieved.
2. Critical test of the stomatal model used at present to derive flux-response relationships, based on existing measurements of stomatal conductance (made by our group or in the literature) – manuscript submitted in September 2001.
3. Quantification of the chamber effect on ozone uptake and plant development rate based on existing data (based on the stomatal model and a large number of open-top chamber experiments performed by our group) and quantification of the difference in ozone load expressed for monitoring height, compared to canopy height (test of existing models based on an extensive data set by our group from 1989). This work will be made in 2002 in addition to the finalisation of the flux-based crop loss assessment methodology.

B. *Forest trees.*
1. Calibration and development of an ozone flux-response model for spruce and a corresponding model for birch (based on experiments performed by our group at Östad during the last ten years).
2. Building up an ozone-flux database, based on data sets from different parts of Europe.
3. Theoretical considerations and analysis of existing data for the extrapolation of relationships obtained using open-top chamber experiments to forest conditions.

An important task during 2002 will be to make contributions (1. flux-based crop loss assessment methodology, 2. short-term critical levels based on clover data, 3. flux-response relationships for spruce and birch) to the workshop on critical levels for ozone to be held in Sweden in November 2002, which is partly funded by ASTA A1.

Active participation by Per Erik Karlsson and Håkan Pleijel at the yearly meeting of ICP-Vegetation in Germany, February 2002 and in a UN-ECE Expert meeting on Ozone deposition in UK, June 2002 (Pleijel member of advisory committee of the meeting).

C4 Particulate air pollution - concentrations, transport and sources

Principal Investigator: Hans Christen Hansson, ITM, Stockholm
Partner: Erik Swietlicki, Lund University
Budget: 2000: 800 kSEK
2001: 800 kSEK
2002: 800 kSEK

Goal: Mapping of sources of long range transported particles, develop a basis for parameterisation of particle formation and evolution. Achieved parameterisation shall be implemented in an EMEP-model for long range transported particles.

Scientific approach and realisation:
Available models describe the concentration of particle bound nitrogen and sulphur compounds. These compounds account for probably 50 – 75% of the total fine particle mass. Organic carbon (OC) and black carbon (BC) are other particle components, of which OC has been shown in limited measurements to account for about 40% of the fine particle mass. Sources and atmospheric processes affecting the OC concentrations are not enough well known to allow a good description of how OC concentrations vary in time and space in the present models. Changes in the emissions of sulphur and nitrogen will affect the particle mass concentrations, although this influence is probably not linear. Restrictions on particle concentrations may probably imply even stronger restrictions on sulphur and nitrogen emissions. This project will focus on the development of simple parameterisations, based on experiments as well as on present process models, to be implemented in available regional models (EMEP). Model results will be evaluated by comparing with measurements from monitoring networks in the Nordic countries and comparisons with source receptor models.

The project consists of several different parts:
Model development and inventory of the sources within the EMEP area will be made within a separate project supported by the Nordic Ministry Council named ”Long-range transport of particulate matter in Nordic countries”. It is co-ordinated by the Norwegian Meteorological Institute with participation by ITM, the Norwegian Air Research Institute, the Finnish Meteorological Institute and the University of Helsinki.

The project within ASTA will focus on field measurements of the major types of particles that are present in the Nordic atmosphere, their chemistry and physical properties identified to be of importance in different atmospheric processes. The results will be used in formulating semi-empirical parameterisation of specific processes. For example, the chemical and physical properties of the particles determine when and how the particles deposit, i.e. dry or by precipitation. The measurements are consequently important for the quality of the description by the model of the particle concentration and deposition pattern, in addition to the description of the chemistry and size.

Measurements are performed at two background sites, Vavihill at Söderåsen, Skåne and Aspvreten, about 100 km south Stockholm during approximately one year. The geographical area and thus possible spatial variability covered is too small to be accepted as representative of all the Nordic countries. However there are ongoing common efforts on starting similar

projects or programmes in Norway and Finland, that will be linked to this project if they are successfully started. The Finnish programme is well under way, since important parameters such as particle size and some chemistry is already measured in ongoing programmes. Hopefully, 1-2 background stations per country will be running in parallel with the Swedish stations. Co-ordination, initiation of needed intercalibrations and common databases will be made from the Swedish project, however further support to other Nordic countries will not be possible within the suggested budget.

At the Swedish sites the following will be measured and analysed:

Parameter	**Method**
Size distribution	Particle spectrometer (DMPS) (5 – 500 nm)
Particle type	Hygroscopic Tandem DMA
Chemical composition	Filter sampling, fine and coarse fraction
Analysis	Inorganic ions (Ion Chromatography)
	OC, BC (Thermal analysis)
Trace analysis	PIXE
Source pattern and composition	Source - Receptor analysis

Particle type and chemical composition will be determined during selected periods, due to financial limitations in the funding.

Networks: Within the ASTA-project the source-receptor modelling will be done to complement and as a control of the source inventory done within the NMC-project, mentioned above. Air Pollution Laboratory, ITM and Department of Nuclear Physics, Lund University will share the tasks within the ASTA-part of the project in close co-operation.

The mapping of the PM2.5/10 concentrations in Sweden, at urban, suburban and background sites will be performed within a specific contract with the Swedish Environmental Protection Agency, Vägverket and Energimyndigheten. The contract also includes measurements and source receptor modelling of the contribution of local sources. Specifically the contribution to pollution from traffic and small-scale wood combustion will be studied. Similar projects are emerging in the other Nordic countries. Agreement on co-ordination and sharing data between the countries has been reached. Intercalibration will also be co-ordinated. This data, especially from background sites, will be essential in evaluating how well the particle description in the EMEP-model succeed in describing the background contribution to the particle mass concentrations. This kind of data will be needed for a longer period, i.e. several years, to facilitate a thorough evaluation of the model and to reach general acceptance of the results.

Deliverables: The main deliverable from the project consortium formed by this project, the mapping project and the NMR-project mentioned above, is a model describing the aerosol mass, PM2.5/10, over the Nordic countries. The specific contribution from ASTA is a necessary detailed characterisation of the ambient aerosol as a basis for the parameterisation and for the direct control of the model results. The first complete model results will be presented in 2001. With this it will follow several publications (see below) on how measurements and parameterisation are performed, which in part sill depend on the ASTA contribution.

Written reports articles etc. are found in the Appendix.

Appendix 1

ASTA

Summary of deliverables from the different activities 2000-2002

Underlined names indicate responsibility for a certain deliverable.

Activity A1:1 International centre for evaluation and assessment

1999 International and National Abatement Strategies for Transboundary Air Pollution Chadwick *Report to the ASTA Programme Board*	Delivered September 1999.
2000 *Presentation at the Critical Loads Workshop in Copenhagen Nov 99.* Critical loads – is there a need for a new concept? Grennfelt, Sverdrup et al ***Referee journal paper***	Grennfelt, P. et al. 2001. Critical loads – is there a need for a new concept? Water, Air and Soil Pollution: Focus 1, 21-27.
2000 Report from workshop on International Air Pollution Strategies – Scientific needs for the revisions of protocols and strategies. Stockholm 10-12 April 2000. Grennfelt et al ***ASTA and NMR report***	Delivered in 2000. ASTA report "Workshop on future needs for regional air pollution strategies", May 2000 NMR report "Workshop on future needs for regional air pollution strategies". TemaNord 2000:557. ISBN:92-893-0484-7
2000 (or 2001) Nitrogen in forest ecosystems. How to balance the negative effects from nitrogen deposition with the positive effects due to its ability to enhance carbon sequestration. Grennfelt and Nilsson *Background papers and workshop report*	A Swedish workshop will be held in the beginning of 2002..
2001 Are the environmental improvements following the model predictions? Lövbladt *Assessment report (probably together with CLRTAP organisations)*	The work started in 2001 in collaboration with the Task Force on Measurements and Modelling. Report expected in 2003.
2002 Evaluation of the control measures and their effectiveness for the traffic sector. *Assessment and workshop report.*	Cancelled. Other subprojects have been chosen.
2002 The role of uncertainties in the development of transboundary air pollution strategies. 1) General issues. Grennfelt 2) Uncertainties in connection with mapping of critical loads and their exceedances. Alveteg and Sverdrup *Presentations at the workshop on uncertainties at IIASA Jan. 2003.*	

2002 Workshop on validation of emission inventories a utumn 2002 *Workshop report.*	
2002 Synthesis report: New aspects on abatement strategies for transboundary air pollution Report to be delivered for the evaluation	
2002 - 2003 Workshop on critical levels for ozone. 1) Background papers. 2) Workshop report. Early 2003	
2000 – 2002 Expert meetings on inclusion of dynamic aspects into the critical loads concept. *Three consecutive workshops and workshop reports.*	Workshop report from the first workshop in Ystad in 2000. Report submitted to the Task Force on Mapping.

Deliverables A1:2

Deliverables for 2000 have been delayed due to uncertainties in financial issues.

2000 Establishment of the ASTA modelling workshop team	Partly completed. One more PhD student will be enrolled early 2001.
2000 Install and test the existing RAINS model for Sweden	Delayed until early 2001
2000 Conceptual design outline for the effects module, ignoring the time aspect	Delayed until early 2001
2001 First version of an effects module including acidification, gaseous effects and nitrogen	
2001 First design for including time in the damage estimate	
2001 A conceptual design for adressing certainties of descicion and uncertainty in estimates, the impact of lack of data and the issue of representativity.	
2001 The first reference discussion group meeting has been held	
2002 Test of a first modified version of RAINS including some type of quantitative effects estimate	
2002 First version of an uncertainty module	
2002 Initial design for a module estimating quantitative risk estimates	
2002 The first reference discussion group meeting has been held	

Activity A2 National strategies for emission control and land use – a national platform

The original deliverables were revised in the beginning of 2001 in co-operation with the special committee connected to the activity (representing the external financiers). The table below shows the revised deliverables. The substituted or revised deliverables are shown in the last table.

2000 Development of system methods	System methods and the different model tools are identified and developed. The application and combinations of models will be studied in different case studies (se below) The work is co-ordinated with ASTA A1:2 and SUFOR.
2000 Effects of decreasing sulphur deposition on surface water chemistry, Westling et al National report	An example from the County of Västra Götaland is studied and reported in co-operation with SLU.
2001 Development of emission scenarios year 2000-2020 for different sectors and future land use in collaboration with sector authorities and branch organisations, Westling Workshop and workshop report	Partly conducted but not as a workshop
2001 *Preparation of land use maps in grids, Ekstrand* Database	A part of the co-operation with RESE. The work will be ready during 2001.
2001-2002 Mapping of soil status (critical loads, base saturation, weathering etc.) in grids (with SLU, LTH) Database	The work is going on, based on the land use map. The database will be adapted to different GIS applications. Will be used by several projects in ASTA.
2001 Method to calculate leaching of nitrogen from clearcuts as a function of nitrogen deposition. Akselsson *Publication in scientific journal.*	A model is developed and applied on South Sweden. The results were presented at the N2001 conference in Washington D.C. Manuscript will be submitted to a scientific journal.
2001-2002 Method to describe acidification from forest growth and harvest, compared to deposition of air pollutants, Moldan et al. *National report (IVL B1424)*	A case study with dynamic modelling (MAGIC), and different scenarios for harvest and compensatory fertilisation, is conducted in a forest stand in South Sweden. Regional calculations will be conducted during 2002.
2001-2002 Scenario analysis (effects of emissions and land use compared with national environmental goals) including control optimisation and other trends, Westling et al *Publication in scientific journal.*	A study of impact of harvest of biofuels on nitrogen fluxes in forests in Sweden was presented at the N2001 conference in Washington D.C. Manuscript will be submitted to a scientific journal.
2001-2002 Concept for regional and long term (dynamic) calculations of nitrogen (and coal) in forest soils in Sweden. Akselsson. *Publication in scientific journal.*	In co-operation with SUFOR (FORSAFE) and LUSTRA (COUP). The models will be applied to data from NITRIX, Gårdsjön.

2002 Study of possible measures (cost/benefit) to counteract acidification of forest soils (combinations of emission reductions and land forestry methods), Westling et al.	
2002 Concept for defining targets for soil chemistry in relation to surface water quality (acidification). Moldan et al.	
2002 Study of measures to counteract rapid changes of nitrogen content of forest soils, Akselsson et al.	
Study of the risk connected to compensatory fertilisation with bases in areas with nitrogen rich soils (risk of increased leaching), Westling et al.	

Substituted or revised deliverables (no longer valid) during 2001.

2000 National emission inventories in grids, Westling *Technical report*	A basis for emission inventories (agriculture, transports) is the land use mapping co-financed by ASTA and RESE during 2001.
2001 Development of a model system with coupling between national and international control strategies, Westling Workshop and workshop report	
2001 Calculation of receptor matrices for national emissions (with SMHI), Persson Technical report	.
2001 Development of control options, including "sector changes"	Some work on land use ready including contacts with LUSTRA.
2002 Scenario analysis (effects of emissions and land use compared with national environmental goals) including control optimisation and other trends, Westling et al *National reports*	A case study of the effects of forestry on surface water in an acidified region in Sweden is ready, co-financed by the County Board of Västra Götaland and the National Board of Forestry .

Activity B Scientific processes behind abatement strategies – a social science perspective

2000 Review of research in the role of science in the regime of transboundary air pollution, Sundqvist & Lidskog *referee journal paper*	Lidskog, R & Sundqvist, G. (2002) "The Role of Science in Environmental Regimes: The Case of LRTAP", *European Journal of International Relations* 8 (1), in press. Lidskog, R. & Elander, I. (1999) "Demokrati, ekologi och kunskap. Statsvetenskapliga responser på miljöproblematiken" (Democracy, ecology and knowledge. Political science responses to the environmental challenge), *Statsvetenskaplig Tidskrift* 102(4): 353–377. Lidskog, R. (1999) "Mot en gränslös demokrati. Politiska responser på globala miljöhot" (Towards an unbounded democracy? Political responses to global environmental threat), *Sociologisk Forskning* 36(4): 40–75.
2000 Analysis of consensus-building within the scientific community with regard to transboundary air pollution, Sundqvist *referee journal paper*	Sundqvist, G., Lettel, M. & Lidskog, R. (2002) "Science and Policy in Air Pollution Abatement Strategies", *Environmental Science & Policy*, forthcoming.
2001 Analysis of the role of science in international agreements on transboundary air pollution, Lidskog *referee journal paper*	Lidskog, R. & Sundqvist, G. *Does science matter? The role of science in international environmental governance*, paper presented at the 5th conference of the European Sociological Association, Helsinki 28 August-1 September 2001. To be submitted in December 2001.
2001 Comparison of the regime for transboundary air pollution with other kinds of regimes (e.g. stratospheric ozone, climate change bio-diversity), Lidskog *referee journal paper*	Lidskog, R. & Sundqvist, G., *From Consensus to Credibility. New challenges for policy-relevant science.* Work in progress, planned to be submitted in March 2002.
2002 Analysis of the role of science and expertise in international policy making, especially transboundary air pollution, Sundqvist *paper in popular science journal, in Swedish*	To be written at the end of the project time, in late 2002.
2002 Analysis of the role of science and expertise in the national re-interpretation of international agreements on transboundary air pollution, Sundqvist & Lidskog *referee journal paper*	Sundqvist, G. & Lidskog, R., *Recovery: A new policy tool from the scientists?*. Work in progress, planned to be submitted in early 2002.
2003 Scientific knowledge, international politics and national implementations: The case of transboundary pollut. Sundqvist & Lidskog *monograph in English published by and international publishing house*	

2004 *PhD-thesis*, the empirical part made within ASTA 2000-2002	Letell, M., *Acid Narratives: The articulation of transboundary air pollution 1972 and 1982*. STS Research Reports no 3. Part of the thesis, to be published in December 2001.

Activity C1:1 Recovery from acidification – Experimental reversal in the roofed catchment and biogeochemical processes

2000 *Status report to Mistra:* Results after nine year of the roof experiment. Moldan et al.	Progress reported at the meeting 21.-22.8.2001
2000 *Presentation at the international conference Acid Rain 2000 in Japan:* Results from the covered catchment experiment. Moldan et al. Referee journal paper	Presented as a key note presentation at Acid Rain 2000, manuscript written. Negotiation with the journal in progress.
2000 Sulphur dynamics in the roof experiment, isotope study, Torssander, Mörth et al. Referee journal paper	Manuscript in progress, expected early in 2001.
2001 Origin of sulphur deposition at Lake Gårdsjön – natural and anthropogenic, Torssander, Mörth et al Referee journal paper	
2002 10 years of acidification reversal at the roof experiment, Moldan et al Referee journal paper	
2002 Roof experiment – extrapolations and implications for predicting recovery from acidification, Moldan et al Referee journal paper	
2002 *Final report to Mistra:* The roof experiment at Gårdsjön, Moldan et al	

Activity C1:2 Tools for modelling the recovery of forest soils and surface waters from acidification

2000 *Presentation at the international conference Acid Rain 2000 in Japan:* Modelling soil chemistry in the Gårdsjön roofed catchment using the SAFE model with sulphate adsorption, Martinson et al *Referee journal paper*	Poster presentation at Acid Rain 2000. Manuscript in progress, will be submitted spring 2002.
2000 *Presentation at the international conference Acid Rain 2000 in Japan:* Regional assessment of soil chemistry dynamics in Sweden using the Safe model, Alveteg et al Referee journal paper	Poster presentation at Acid Rain 2000. Article postponed after suggestions for revisions:The model setup have been revised in cooperation with Swiss and German researchers. The Swedish database is being revised after in-depth discussions with other researchers. Article planned 2002, after publication of regional modelling manual (see below).
2000 *Progress report to Mistra:* Regional assessment of soil chemistry dynamics in Sweden using national forest inventory, national deposition estimates and SAFE/MAKEDEP models, Alveteg et al	A manual on regional modelling with SAFE/MAKEDEP including the data preparation for Sweden and the results of the Swedish application is in progress. To be published 2002 in *Reports in ecology and environmental engineering*
2000 *Presentation at the international conference Acid Rain 2000 in Japan:* Extrapolating the 9 years of results from Gårdsjön covered catchment with the MAGIC model, Moldan et al Referee journal paper	Poster presented at Acid Rain 2000. Won the first prize in best poster award. Manuscript "Terrestrial ecosystem recovery - Modelling the effects of reduced acidic inputs and increased inpupt of sea-salts induced by the global change. Beier, C., Moldan, F and Wright R.F. submitted to Ambio.
2000 *Progress report to Mistra:* Methodology and preliminary assessment of acidification status in stream waters in Sweden, Bishop et al	Progress Report submitted November, 2000. Title: Progress Report to MISTRA-ASTA SLU's Component of Project C1:2 Tools for modelling the recovery of forest soils and surface waters from acidification Kevin Bishop and Pavel Kram SLU Dept. of Environmental Assessment
2001 *Conference presentation:* Methods to include dynamic aspects of soil acidification and recovery in abatement strategies, Martinson et al. Referee journal paper	Poster presentation (recovery isolines) at Acid Rain conference 2000. Planned article 2002 by Alveteg et. al. (Postponed due to lack of additional funding)
2001 *Methods report* to TFIAM on dynamic modelling, Alveteg	Planned contribution at ICP Mapping meeting in April 2002.
2001 *Conference presentation:* Acidification and recovery in Swedish stream waters, Kram et al Referee journal paper	Presented at the Nordic Hydrological Conference, Uppsala, June 2000. Modelling Long-term Streamwater Chemistry in the Brg Catchment, Southwestern Sweden, Kram, P., Bishop, K. and Moldan, F. 2001. Nordic Hydrology, 32, (3), 249-264.

2001 Time series of water quality measurements as compared to model simulations of soil and stream water acidification in Sweden, Kram, Martinson & Moldan Referee journal paper	Postponed to 2002
2002 *Conference presentation:* Effects of different emission scenarios on soil chemistry in Sweden, Alveteg et al Referee journal paper	Manuscript on scenario analysis for selected Swiss and Swedish forest sites is in progress. Will be submitted spring 2002 by Martinsson et. al.
2002 *Conference presentation:*Implementing nutrient content elasticity in the MAKEDEP model, Alveteg et al Referee journal paper	**New**. To be presented at SUFOR workshop 2002
2002 *Conference presentation:*Effects of sulphate adsorption on the recovery from acidification at Gårdsjön using SAFE, Martinsson et al Referee journal paper	**New**. To be presented at Biogeomon 2002
2002 *Conference presentation:* Effects of different emission scenarios on runoff chemistry in Sweden, Moldan et al Referee journal paper	
2002 *Conference presentation:* Evaluating a dynamic alternative to critical loads on a national scale, Martinson et al Referee journal paper	Postponed to 2003 (phase 2) due to lack of planned additional funding.
2002 *Report to Swedish Environmental Protection Agency and UN/CCE:* Dynamic critical loads, Alveteg	Postponed to 2003 (phase 2) due to lack of planned additional funding.
2002 Synthesis report to Mistra, *Alveteg*	Postponed to phase 2 due to lack of planned additional funding.

Activities C2:1 & C2:2 Nitrogen dose and nitrogen form – ecophysiological responses & vegetation responses

2000 Dramatic shift in boreal forest vegetation mediated by parasitic fungi, Näsholm m fl. *referee journal paper*	Strengbom, J., Nordin, A., Näsholm, T. and Ericson, L. 2001. Parasitic fungus mediates vegetational changes in nitrogen exposed boreal forest. Journal of Ecology, in press
2000 Effects of five years of nitrogen deposition on nitrogen uptake and vegetation response in a boreal forest, Näsholm et al *referee journal paper*	Presented as a poster at the Critical Loads meeting in Copenhagen 1999. Scheduled for submission 2002. Additionally, two articles discussing the role of organic N in boreal forests and the possible effects of a shift towards inorganic N through N deposition have been produced (Näsholm, T. and Persson, J. 2001. Organic nitrogen acquisition by Boreal forest plants. Commisioned review, Physiologia Plantarum 111: 419-426 (published) and Lipson, D. and Näsholm, T. 2001. The unexpected versatility of plants: Organic Nitrogen Use and Availability in Terrestrial Ecosystems. Commissioned review. Oecologia 128: 305-316 (published))

2001 Different effects of ammonium and nitrate on boreal forest vegetation, Ericson et al *referee journal paper*	Scheduled for submission 2002 The role of different N sources for forest plants, lichens and trees have been described in the following papers: Persson, J. and Näsholm, T. 2001. A method for analysis of plant amino acid uptake through GC-MS of dual labeled compounds. Physiologia Plantarum, 113: 352-358 published Persson, J. and Näsholm, T. 2001. Amino acid uptake, a widespread capacity among boreal forest plants. Ecology Letters, 4: 434-438 published Persson, J. and Näsholm, T. 0000. Amino acid uptake is regulated by N status and resource access in Scots pine. Submitted manuscript Dahlman, L., Näsholm, T. and Palmkvist, K. 0000. Growth, nitrogen uptake and resource allocation in the two tripartite lichens species *Nephroma arcticum* (L.) Torss. and *Peltigera aphthosa* (L.) Wild during nitrogen stress. New Phytologist, accepted manuscript Sundberg, B., Näsholm, T. and Palmquist, K. 2001. Effects of nitrogen on partitioning of biomass between algal and fungal bionts in the lichens *Nephroma arcticum* and *Peltigera aphtosa*. Plant Cell & Environment 24: 517-527 published
2001 Slow recovery of vegetation following a decrease in nitrogen supply, Ericson et al *referee journal paper*	Strengbom, J., Nordin, A., Näsholm, T. and Ericson, L. 2001. Slow recovery of Boreal forest ecosystem following decreased nitrogen input. Functional Ecology, 15, 451-457 published

Additional production during 2001	Strengbom, J., Walheim, M., Näsholm, T. and Ericson, L. 0000. The occurrence of ericaceous species along a nitrogen deposition gradient in Sweden. Submitted manuscript (Ambio) Strengbom, J., Näsholm, T. and Ericson, L. 0000. Light, not nitrogen, triggers expansion of the grass *Deschampsia flexuosa* in boreal forests. Manuscript ready for submission. Witzel, J., Gref, R. and Näsholm, T. Plant –part specific and temporal variation in phenolic compounds of boreal forest plants Submitted manuscript. Öhlund, J. and Näsholm, T. 2001. Growth of conifer seedlings on organic and inorganic nitrogen sources. Tree Physiology 21: 1319-1326. published
2002 Mechanisms behind vegetation recovery following a sharp decline in nitrogen supply, Näsholm et al *referee journal paper*	
2002 The effects of monophagous vs. polyphagous natural enemies on plant community structure following increased nitrogen deposition, Ericson et al *referee journal paper*	
2002 The importance of scale in interpreting experimental nitrogen additions, Ericson et al *referee journal paper*	Strengbom, J. & Ericson, L. Importance of spatial scale for field simulation experiments: example from N fertilization of a boreal forest. Manuscript ready for submission Jan 2002
2002 A conceptual model that direct interspecies competition in boreal forest at elevated levels of nitrogen supply, Näsholm et al *referee journal paper*	Presented in: Nitrogen, parasites and plants – key interactions in boreal forest ecosystems. Strengbom, J. Thesis Umeå University 2001. To be printed Dec 2001

Activity C2:3 Effects of nitrogen deposition in forest ecosystems on ground-layer species dynamics

2000 *Conference presentation:* Acid Rain conference in Japan 2000, Falkengren-Grerup *referee journal paper*	Left out due to long-term illness Invited speaker, chairperson of working group "Temporal and spatial uncertainties in use of biological responses to nitrogen" and member of the team responsible for summarising the outcome of the Conference on Critical Loads. Lökke H, Bobbink R, Bull K, Curtis C, Falkengren-Grerup U, Forsius M, Gundersen P, Hornung M, Skjelkvale B L, Starr, M & Tybirk K. 2000. Critical Loads Copenhagen 1999. 21-25 November 1999. Conference Report prepared by the members of the conference's secretariat, the scientific committee and chairmen and rapporteurs of its workshops in consultation with the UN/ECE secretariat. Critical Loads. National Environmental Research Institute, Denmark. 1-48. – Arbejdsrapport fra DMU No. 121.
Additional production during 2000	Falkengren-Grerup U, Ericson L, Gunnarsson U, Nordin A, Rydin H and Wallén B. 2000. Förändras floran av kvävenedfallet? I: Bertills U & Näsholm T (utg.) Effekter av kvävenedfall på skogsekosystem. Naturvårdsverket, Stockholm, Rapport 5066, 75-100. Falkengren-Grerup U, Ericson L, Gunnarsson U, Nordin A, Rydin H & Wallén B. 2000. Does nitrogen deposition change the flora? In: Bertils U & Näsholm T (eds). Effects of nitrogen deposition on forest ecosystems. Naturvårdsverket, Stockholm. Report 5067, 77-104.
2001 Impact on soil mineralisation and vegetation of nitrogen deposition in a gradient in Sweden, Falkengren-Grerup *referee journal paper*	Falkengren-Grerup U and Diekmann M. Use of a gradient of N-deposition to calculate effect-related soil and vegetation measures in deciduous forests. Manuscript ready for submission.

Additional production during 2001	Olsson M O, Falkengren-Grerup U, Michelsen A, Sleep D and Quarmby C. Assessing forbs' preference for nitrate by measurement of plant natural abundance of ^{15}N and soil N mineralisation. Submitted manuscript. Olsson M O and Falkengren-Grerup U. Partitioning of nitrate uptake between trees and understorey in oak forests. Submitted manuscript. Månsson K F and Falkengren-Grerup U. Increased soil microbial activity and organic matter quality in oak forests exposed to nitrogen deposition Submitted manuscript.
2002 Nitrogen specialists and generalists indicate spatial and temporal changes in the forest vegetation, Falkengren-Grerup *referee journal paper*	Falkengren-Grerup U and Schöttelndreier M Nitrogen specialists and generalists indicate spatial and temporal changes in the forest vegetation. Manuscript scheduled for submission 2001.
2002 Plant functional types – a tool to characterise nitrogen induced vegetation change, Falkengren-Grerup *referee journal paper*	Diekmann M and Falkengren-Grerup U. Prediction of species response to atmospheric nitrogen deposition. 2001. Journal of Ecology, in press.
2002 Critical loads for deciduous forests of varying vulnerability derived from changes in understorey species, Falkengren-Grerup *referee journal paper*	

Activity C3 Ground level ozone

2000 Quantification of chamber effects and vertical gradient effects on ozone flux to crops, Pleijel et al *referee journal paper*	Mainly presented in Pleijel, H., Danielsson, H., Pihl Karlsson, G., Gelang, J., Karlsson, P. E. & Selldén, G. (2000). "An ozone flux-response relationship for wheat". *Environ. Pollut. 109, 453-462.* Additional work on the chamber effect in progress.
2000 Development of flux-response models for spruce and birch, Karlsson et al *referee journal paper*	P.E. Karlsson, H. Pleijel, G. Pihl Karlsson, E.L. Medin, L. Skärby. 2000. Simulations of stomatal conductance and ozone uptake to Norway spruce saplings in open-top chambers. Environmental Pollution 109, 443-451. Work with birch in progress.
2001 Development of an ozone flux-response relationship for potato, Pleijel et al *referee journal paper*	Manuscript was submitted, reviewed and resubmitted during 2001, presently awaiting final decision for publication. Pleijel H., Danielsson, H., Vandermeiren, K., Blum, C., Colls, J. & Ojanperä, K.: "Stomatal conductance and ozone exposure in relation to potato tuber yield – result from the European CHIP programme". Accepted in: *European Journal of Agronomy*, condition: revision.
2001 Test of ozone flux models on data sets for birch and spruce from different parts of Europe, Karlsson et al *referee journal paper*	"Ozone flux - tree response initiative" was starated during the summer 2001, with an inventory electronic circular to scientists which might contribute with appropriate data. This activity will be completed and presented at the ozone workshop in Nov 2002.
	Ozone flux - response relationship for ozone impact on the biomass accumulation of young Norway spruce trees. This work is nearly completed and will appear in manuscript form before the end of 2001.
	Ozone flux - response relationship for ozone impact on the biomass accumulation of young European silver birch trees. This work is on-going and will be completed and presented at the ozone workshop Nov 2002.
	Karlstad Large Norway spruce Tree Ozone Uptake Project. Ozone uptake to needles of 80-year-old Norway spruce trees will be estimated in this on-going project. First results will be presented at the ozone workshop Nov 2002.
	Ozone uptake to leaves of mature European silver birch trees. Ongoing project. First results will be presented at the ozone workshop Nov 2002.

2002 *Conference presentation:* A suggestion of a crop loss methodology for ozone, Pleijel et al *referee journal paper*	Largely covered by two manuscripts both submitted to the *Science of the Total Enviornment:* Danielsson, H., Pihl Karlsson, G., Karlsson, P. E. & Pleijel, H. Ozone uptake modelling and flux-response relationships – assessments of ozone-induced yield loss in spring wheat. Pihl Karlsson, G., Karlsson, P. E., Danielsson, H. & Pleijel, H. Clover as a tool for bioindication of phytotoxic ozone – 5 years of experience from Southern Sweden – consequences for the short-term critical level. Relevant for this are also: Gelang, J., Pleijel, H., Sild, E., Danielsson, H., Younis, S. & Selldén, G. (2000). Rate and duration of grain filling in relation to flag leaf senescence and grain yield in spring wheat (*Triticum aestivum* L.) exposed to different concentrations of ozone. *Physiologia Plantarum* **110***,* 366-375. Soja, G., Barnes, J., Posch, M., Vandermeiren, K., Pleijel, H. & Mills, G. (2000). Phenolgical weighting of ozone exposures in the calculation of critical levels for wheat, bean and plantain. *Environmental Pollution* **109**, 517-524. Further results will be presented at the ozone workshop in Sweden, November 2002.
	Ozone flux - response relationship for ozone impact on the biomass accumulation of young European silver birch trees. This work is on-going and will be completed and presented at the ozone workshop Nov 2002.
2002 *Conference presentation:* Extrapolation of ozone dose-response relationships from experiments to forest ecosystems, Karlsson et al *referee journal paper*	A presentation related to this subject is planned for the Ozone Critical Level workshop in Göteborg Nov 2002, see below.
	A workshop; "Ozone Critical Levels II" under UN-ECE CLRTAP, will be organized by Per Erik Karlsson, Håkan Pleijel and Gun Selldén in Göteborg in Nov 2002. This workshop will be the most important forum to suggest revised ozone critical levels for the revision of the Gothenburg protocol. A workshop report will be produced shortly after the workshop.

	The crop part of C3 will in addition deliver contributions to the ozone workshop in Sweden, November 2002 concerning the validation of flux-response-relationships based on further data, a conductance model for clover and the application of flux-response relationships for actual yield loss estimations.

Activity C4 Particulate air pollution –concentrations, transport and sources

2001 Instrumentation development for long-term aerosol particle size distribution measurements at a background site *Referee journal paper*	B.G. Martinsson, M.N.A. Karlsson, G. Frank, Methodology to estimate the transfer function of individual differential mobility analyzers, Aerosol Science and Technology, 35(2001)815-823.
2001 Major chemical components determining the particulate mass in the atmosphere aerosol in the Nordic countries *Referee journal paper*	*Kommer*
2002 Determination of the organic fraction and some organic components in the Nordic atmospheric aerosol *Referee journal paper*	*Kommer*
2002 Source profiles on traffic and wood combustion emissions, physical and chemical characteristics *referee journal paper*	En artikel inskickad till ES&T +Diverse konferensbidrag om vedeldning och trafik, se listan ovan.
2002 Hygroscopic properties of sub-micrometer atmospheric aerosol particles at a background site in southern Sweden – relation to air mass origin. *referee journal paper*	Kommer
PhD thesis: Climatology of the Nordic aerosol and its relation to season and other meteorological factors. (Licensiat thesis in 2002)	Kommer
PhD thesis: Source-receptor relationships for the long-range transported atmospheric aerosol. (Licesiat thesis in 2002)	*Kommer*

Activity D2 Communications of the results of the ASTA Programme (prepared in 2000)

2000 Yearly report of the ASTA programme (in Swedish)	Årsrapport 99 (30s)
2000 Homepage for the ASTA programme	asta.ivl.se
2000 Brochure of the ASTA programme in Swedish and English	English broschure printed. Swedish broschure postponed due to financial restrictions.
2000-2002 Presentations of the ASTA programme at seminars, conferences etc.	The ASTA programme has been presented at a number of occasions; Elforsk Seminar Aug. 2000 (oral) Acid Rain conference in Japan Dec. 2000. Poster presentation of the ASTA programme. Oral presentation (P. Grennfelt) on scientific challenges within the field of regional air pollution. ASTA research facilities have been visited and results have been presented e.g. Lake Gårdsjön (C1), Vindeln (C2).
2000 Presentations of the ASTA programme at meetings, workshops etc in connection with CLRTAP and EU.	2000: ASTA was the main organiser of the Saltsjöbaden workshop at which The commission, EEA and all subsidary bodies of the LRTAP convention were present. Short presentations of the programme have been given at various groups under the LRTAP Convention EMEP, TFIAM, TFMM, TFEIP, TFMapping EB etc.) and at the Air Quality Group at the European Commission. (See also under A1).
2001 Yearly report in English	
2001 Presentations of the ASTA programme for national stakeholders.	
2000-2002 PhD courses. Minimum four short PhD courses during 2001-2002.	A first introductory course was held in Lund at the end of November 2000. A short course on international negotiations and agreements will be held in Göteborg in Feb-March 2001 and a course on nitrogen and environmental effects during the summer 2001.
2002 Yearly report in English and Swedish	