

Forskningsprogram <input type="checkbox"/>					
SNAP <input checked="" type="checkbox"/> REPROSAFE FLIPP Inriktning: Ekonomiska styrmedel Inriktning: Informationssystem och indikatorer					
Projekttitel (svensk): Att skatta exponering – jämförelse mellan mätningar och beräkningar baserade på spridningsmodellering (EXPOSE)					
Projekttitel (engelsk): Exposure – comparison between measurements and calculations based on dispersion modelling (EXPOSE)					
Huvudsökande	Efternamn:	Förnamn:	Födelseår:	Kvinna	
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Miljöforskningsnämnden

Ansökan om projektbidrag inom Naturvårdsverkets forskningsprogram

Sammanfattning på svenska strukturerad enligt följande: 1) Projektets betydelse för programmet
2) Miljörelevans och förväntad betydelse för miljöpolitiken 3) Mål och hypotes 4) Metodik och genomförande
5) Kommunikationsinsatser i relation till programmet:

1) För att till fullo förstå betydelsen av luftföroreningars effekter för folkhälsan behövs verktyg som ger kännedom om relationen mellan utsläppen av olika föroreningar, befolkningens exponering och hälsoutfallet. Både den totala exponeringen och olika enskilda källors betydelse för exponeringen kan skattas med hjälp av beräkningar av halterna med meteorologiska spridningsmodeller baserat på detaljerad information om utsläppens geografiska och tidsmässiga fördelning. De flesta exponeringsuppskattningar som gjorts baseras på personburen exponeringsmätning. Sådana mätningar kan dock göras på ett begränsat antal individer, är arbetskrävande och medger inte uppdelning av vilka källor som bidrar till exponeringen.

2) Kunskap om betydelsen av olika föroreningskällor för folkhälsan är nödvändig vid prioriteringen av åtgärder som syftar till att minska luftföroreningarnas hälsoeffekter och för att förstå vad framtida utsläpp kan komma att betyda för människors hälsa. Beräkningar av exponering är komplexa och det är viktigt att beräkningsmetoderna blir vetenskapligt utprovade.

3) Målet är att bestämma noggrannheten i exponeringsberäkningar baserat på meteorologiska spridningsmodeller, detaljerade emissionsdatabaser och geografiskt upplösta befolkningsdata. Hypotesen är att dessa beräkningar ger god överensstämmelse med personburen exponeringsmätning för NO₂ och PM_{2.5} samt bensen.

4) Beräkningar av exponering med spridningsmodeller genomförs i Stockholm, Göteborg och Malmö. Beräknad exponering för bensen, NO₂ och PM_{2.5} kommer att jämföras med uppmätt personburen exponering och/eller bostadsrelaterade halter. Jämförelserna görs för dygn och/eller vecka och för Stockholm även avseende månad och år. Beräkningarna genomförs med liknande modeller och emissionsdata avseende geografisk upplösning. Städerna skiljer sig åt vad gäller föroreningshalter, t ex är inflytandet av bakgrundshalterna högre i Malmö än i Göteborg och Stockholm. Genom att jämföra resultaten mellan städerna ökar möjligheterna att förstå orsakerna till eventuella skillnader mellan beräknad och uppmätt exponering. Projektet är ett samarbete mellan luftföroreningsexperter och medicinsk expertis. I projektet ingår representanter för de tre kommunerna (Miljöförvaltningarna),

5) Projektet föreslås som en del i SNAP programmet och resultaten kommer att rapporteras vid konferenser/seminarier och i vetenskaplig litteratur. I början av projektet (2004) hålls en gemensam workshop där arbetet samplaneras och i slutet av 2005 hålls en gemensam konferens där alla resultat presenteras.

	År 2004	År 2005
Summa sökta medel per år i kr:	1 722 000	1 110 000

Miljöforskningsnämnden
Ansökan om projektbidrag inom Naturvårdsverkets forskningsprogram

Sökta projektmedel fördelade på kostnadsslag	År 2004 (k)	År 2005 (k)
Personalkostnad inkl. soc. avgifter* <i>Namn och tjänster specificeras i Bilagan</i>		
<u>Stockholms del</u>		
Exponeringsmätningar	270 000	
Emissionsdata, spridningsberäkningar	180 000	
Utvärdering rapportering		360 000
<u>Göteborgs del:</u>		
Exponeringsmätningar	135 000	
Emissionsdata, spridningsberäkningar	270 000	
Utvärdering rapportering		270 000
<u>Malmö del:</u>		
Exponeringsmätningar, GPS kodning	135 000	
Emissionsdata, spridningsberäkningar, kombinerad m GPS kodn	270 000	
Utvärdering rapportering		270 000
Övriga omkostn exkl moms (förbrukningsmtrl, analyser, resor etc)**		
<u>Stockholms del:</u>		
Exponeringsutrustning	150 000	
Workshops, Resor	10 000	10 000
<u>Göteborgs del:</u>		
Workshops, Resor	10 000	10 000
<u>Malmö del:</u>		
Workshops, Resor	10 000	10 000
Delsumma av ovanstående poster:	1 440 000	930 000
Förvaltningspåslag: 20%		
Stockholm	120 000	72 000
Göteborg	81 000	54 000
Malmö	81 000	54 000
Totalsumma per år: (införs sid. 1):	1 722 000	1 110 000

*) Specificera namn, tjänst **) Specificera

Samtliga övriga miljörelaterade projekt för vilka de sökande har beviljats anslag eller söker anslag för 2004-2006. OBS Även EU-finansiering.

Projekttitel	Finansiär	Tidsperiod	Sökt kr	Beviljat kr
Personlig exponering för små partiklar (GS)	SNAP	2001-04		1 500 000
Exponering för halogenerade Anestesigaser (GS)	FAS	2002-04		1 400 000
Exponering för cancerframkallande ämnen i tätortsluft (HT)	Naturvårdsverk	2003-04		1 000 000
Utv. & validering av modell för beräkning av PM10 i urban miljö (CJ)	Vägverket	2002-04		1 487 000
Partiklar i stadsmiljö — utsläpp, spridning och hälsoeffektskattningar med dos- respons samband (CJ)	SNAP	2001-04		2 100 000
Betydelsen av långdistanstransporterade luftföroreningar för hälsoeffekter observerade i Stockholms län (CJ/ITM)	SNAP	2004-05	2 121 152	

Miljöforskningsnämnden
Ansökan om projektbidrag inom Naturvårdsverkets forskningsprogram

Miljörelaterade projekt för vilka sökande har beviljats anslag för 2000-2003
OBS Även EU-finansiering

Projekttitel	Finansiär	Tidsperiod	Beviljat Kr
Allmänbefolkningens exponering för toluen och xylen (GS)	Länsstyrelsen	2002-03	120 000
Partiklar i stadsmiljö — utsläpp, spridning och hälsoeffektskattningar med dos-respons samband (CJ)	Vinnova	2001-03	1 868 000
Flöden till luften av partiklar och metaller i Stockholm (CJ/ITM)	Vinnova	2001-03	608 760
ALVA (TB)	NV/Formas	2001-03	1 320 000
SENSI (TB)	NV/SNAP	2003	499 969
Airgene (TB)	EU	2003	979 560
Luftkvalité i små barns inomhusmiljö	NV/SNAP	2002-03	859 916
Cohort Feasability	NV/SNAP	2002-03	297 000
INDEX	Vägverket	2000	333 333
ONSET	NV/SNAP	2002-03	500 000

Datum och sökandes underskrift, vilken samtidigt ger Naturvårdsverket tillåtelse att publicera sökandes namn på sin webbplats:	Datum och underskrift av prefekt eller motsvarande med namnförtydligande:
 Christer Johansson	 Tage Jonson, Enhetschef

Proposal of an activity as part of the SNAP programme

Exposure – comparison between measurements and calculations based on dispersion modelling (EXPOSE)

Keywords: NO₂, PM_{2.5}, benzene, personal exposure, health impact assessment

1 Background & importance for the SNAP programme

Quantification of population exposure to various air pollutants is essential for understanding the associations between health and air pollution. The exposure can be estimated either from measurements using fixed monitors, samplers carried by individual persons, or based on calculated temporal and geographic distributions of air pollutants. Calculations of the geographical distribution of air pollutants may be obtained using air quality dispersion models, building on emission inventories with high spatial resolution (typically 10-500 m squares in built-up areas). Based on the geographical distribution of the population, the population exposure can then be calculated. The use of dispersion models for calculating exposure allows evaluation of the importance of individual emissions for the population exposure and hence also the health effects.

In Stockholm, an air quality management system (AQMS) was used to perform such exposure calculations as part of a health impact assessment (the "SHAPE" project; Johansson et al., 1999) and as part of case-referent study of lung cancer (the "LUCAS" project; Bellander et al, 2001). Later, population exposure has been calculated for NO₂ and PM₁₀ to assess health impacts of road pricing in Stockholm (Johansson et al., 2003; Forsberg et al., 2003a; Forsberg et al., 2003a). Similar assessments are used in an ongoing SNAP study: LEAP – Long Term Exposure to Air Pollution and Myocardial Infarction. Similar models are also currently being implemented for similar purposes in Malmö/Lund in a SNAP project (I-43-01), and proposed to be implemented in Göteborg, as described in a separate application to SNAP ("APPOLLON"). Where there are no emission inventories, more simple methods of geographical exposure assessment may be applied.

In addition to the assessments of long-term averages of outdoor levels, there is a need of developing assessment of spatial fields of exposure levels in shorter time periods; days to weeks. This will allow for both direct comparisons with measurements in this time frame, and for attribution of address-based short-term exposure levels in epidemiological studies. Validation of all the described types of exposure models is essential. Such validations should involve comparisons of calculated exposure with actually measured area-based levels as well as with measurements of individual exposure. There are some examples of temporal validation of NO₂ and NO_x in a single point (eg Walker et al 1999; Johansson et al., 1999).

The availability of quality-controlled methods for the assessment of front-door concentrations and personal exposure levels in short and long time frames will be a major advantage in future research and risk assessment. Emission inventories with high geographical detail are fairly new in the Nordic countries and to now virtually inexistent in other countries. The Nordic countries are world leading in the development of this type of modelling in environmental health, but the lack of quality control has hampered the development of similar systems in other countries.

2 Aims and hypothesis

The aims are:

- To quantify personal exposure to benzene, NO₂ and PM_{2.5} for selected persons in Stockholm, Gothenburg and Malmö by using meteorological air quality dispersion models and detailed emission data.
- To compare calculated exposure with actually measured personal exposure and/or front-door levels.
- To assess the accuracy of a GIS based approach to quantify exposure calculations both as short term averages (days to weeks) and long term averages (year).

The hypothesis is that meteorological dispersion models and information on peoples' working and living addresses and their travelling can be used to estimate exposure to air pollutants. But the accuracy of the exposure quantification using dispersion models depends on the accuracy of the emission data, that may depend on the substance under study, and on the spatial distribution of the emissions in relation to where people live and work. The problem addressed requires a multi-disciplinary approach involving expertise on emissions, chemistry, physics, meteorology, exposure assessment and medicine. Effective progress on this topic can only be attained by co-operation between specialists from different research disciplines.

3 Methodology and implementation

This project is a co-operation between experts in environmental air quality and environmental hygiene and medicine. Experts from local environmental authorities of Stockholm, Gothenburg and Malmö are part of the project.

3.1 Personal Exposure data

3.1.1 Stockholm

In Stockholm there are personal measurements of NO₂ from 240 persons 2*1 week during 1999/2000, in 80 of these also benzene (The INDEX project; Bellander et al manuscript in preparation). A similar data collection in 2003 provided another 60 one-week samples from 40 individuals, both NO₂ and benzene (Health-related environmental monitoring programme, Kruså et al manuscript in preparation). In addition there are 500 one-month measurements from 500 front doors in 1995-1999 and of a total of 168 measurements of NO₂, PM_{2.5} and PM_{2.5}-absorbance (soot) from 42 outdoor places in 1999/2000. Ongoing data collections include 40 personal samples of NO₂ in 20 children and 80 front-door area samples.

3.1.2 Gothenburg

In Göteborg personal measurements of NO₂ and benzene were performed both in 1999 (Barregård et al 1999, Sällsten 1999) and in 2000 (Sällsten et al 2002). Within a SNAP-project (Personal exposure to fine particles) personal measurements of fine particles, PM_{2.5}, have been conducted in 2002-2003.

In total there are 130 individual benzene exposure samples from 76 subjects collected either during 24 hours or in a six days sampling period. In 40 of these cases we also have residential outdoor and indoor levels of benzene.

For NO₂ we have 20 personal exposure samples as well as 20 residential outdoor levels collected in 1999. Area sampling has been performed to a limited extent within the studies, but in Göteborg there are continuous measurements of both benzene and NO₂ at several fixed locations run by the local Environmental authorities. For PM_{2.5} we have personal as well as residential indoor and outdoor

measurements and area sampling at one central location in the city (Johansson et al 2003). In total there are about 150 samples collected during spring or autumn periods in 2002 and 2003. There are also limited results from personal measurements of benzo(a)pyrene (N=7) from 2000.

3.1.3 Malmö

In an ongoing project personal measurements of NO₂ and benzene are collected in Malmö for 40 subjects. For 20 of them two measurements will be performed. We will have their residential and occupational coordinates. Moreover, we are planning to equip up to 5 of the subjects with GPS-monitors to increase the accuracy of the modelled results. With the GPS-monitors we will have the subjects exact location during the whole measurement period. In the above project also area sampling will be performed and furthermore the environmental authorities in Malmö have performed continuous measurements of NO₂ and PM_{2.5} at several fixed locations during several years. We also plan to perform a small pilot study within this project where personal exposure to PM_{2.5} and NO₂ at 5 different locations in Skåne will be measured. Also these measurements will be combined with data from GPS-monitors. This pilot study will evaluate the performance of modelling NO₂ and PM_{2.5} also in other cities and in rural areas in the Scania region.

3.2 Exposure calculations

3.2.1 General

Gaussian dispersion models will be run for specific time periods corresponding to periods when personal exposure measurement data have been taken. The measured exposure will be compared with the calculated exposure for the three cities. Detailed emission data bases, meteorological data and dispersion models exist already for the cities.

Since several years all three cities (Stockholm, Gothenburg and Malmö) have been using Air Quality Management Systems that involve dispersion models and detailed emission inventories. These systems are being used in Environmental Impact assessments for urban planning, mainly traffic planning. A number of reports may be found on the homepages of the Environment and Health Administrations (Stockholm: <http://www.slb.nu>, Gothenburg: <http://www.goteborg.se>, Malmö: <http://www.malmo.se>). All three cities have a number of fixed air pollutant monitoring stations that are used to assess the accuracy of the calculations. For Stockholm such validation was performed for NO₂ and PM₁₀ as part of the SHAPE project (Johansson et al., 1999). Later more detailed validation for PM₁₀ was performed in the county of Stockholm as part of the mapping PM₁₀ for assessment of exceedances of the new air quality standard (Brydolf et al., 2001).

3.2.2 Stockholm

For Stockholm the calculations of exposure will be performed by SLB at the Environment and Health Protection Administration of Stockholm. SLB is the operator of the AQMS of the Stockholm and Uppsala regional air quality association (Airviro). The system is described in Johansson et al. (1999) and also on the web sites of SLB (<http://slb.nu>).

3.2.3 Gothenburg

For Gothenburg the calculation will be performed by the Environment and Health Protection Administration (EHPA) of Göteborg. An updated version (2004) of ENVIMAN will be used where also a module for street-modelling is included. The system is described on the web-site <http://www.goteborg.se>. Modelling of personal exposure of air pollutants will also be performed within another project (APPOLON, if financed by SNAP) managed by Kjell Toren and Bertil Forsberg in cooperation with EHPA. The validation of the modelling method used in Göteborg will therefore be of value also for that project.

3.2.4 Malmö

For Malmö the calculations of exposure will be performed by the GIS-centre at Lund University and by the Environment and Health Protection Administration of Malmö. The modelling of exposure will be performed with ENVIMAN. The import of pollutants will be added as a day to day factor from actual measurements at Vavihill.

3.3 Time plan

A common planning workshop will be held in the beginning of 2004 and in 2005 we plan to have a common workshop where all the results will be presented.

3.3.1 Stockholm

Exposure calculations will be performed for NO₂, PM_{2.5} and benzene. For NO₂ (280 persons) and benzene (80 persons), measured personal exposure data already exist and calculations for this period will be performed during 2004. Front door data exist for 582 locations. For PM_{2.5}, front-door data will be available for 82 locations, and indoor data from 40 of these. New personal data will be collected during the winter 2004/5 (40 persons). Indoor sources will be characterised for these persons.

3.3.2 Gothenburg

Exposure calculations will be performed for NO₂, PM_{2.5} and benzene. In 2004 we will have access to all measurement data. Information on localisation and sampling period for all measurement will be collected and GIS coded during 2004. Modelling of NO₂ for the year 1999 will be performed during the first half of 2004 and validated against personal and outdoor measurements. In the second half of 2004 modelling of benzene and PM_{2.5} will start and the results will be validated against residential outdoor measurements. Modelling and validation of personal measurements will be performed in 2005.

3.3.3 Malmö

Exposure calculations will be performed for NO₂, PM_{2.5} and benzene in Malmö and for NO₂ and PM_{2.5} for Scania. For NO₂ and benzene in Malmö the measurements are performed in an ongoing project and will be finalised during 2003. For NO₂ in Scania and for the PM_{2.5} exposure, the measurements will be performed during the spring 2004.

The modelling and validation procedure will start during late spring 2004 with first the comparison between stationary NO₂ and PM_{2.5} and modelled data and thereafter with the personal NO₂ data. When that procedure is started the personal measurements combined with the GPS-data will be modelled. The outcome of these comparisons with and without the GPS-data will highlight the importance of knowing the exact localization and calculate the order of misclassification. The procedure will then continue with calculations for Scania where the local emissions are of lower importance than in Malmö. In the second half of 2004 modelling of benzene will start. The modelling plans to be finalised in the summer 2005.

4 Costs

The two project workshops will be co-organised with the working group meetings of the SNAP exposure & epidemiology.

4.1 Stockholm

The model calculations for Stockholm will be performed by Christer Johansson. GIS calculations will be made by Boel Lövenheim and the emission database control by Malin Pettersson. The exposure measurements for NO₂ and benzene in Stockholm have already been performed and the major costs for exposure measurements are for personal measurements of PM_{2.5}, that have not previously been performed in Stockholm. Assistant professor Tom Bellander from the department of occupational and environmental health will lead this part, and Malin Nilsson and Martin Kruså will participate.

4.2 Gothenburg

In Göteborg the following staff from the Department of Occupational Medicine at Sahlgrenska Academy will be engaged: Ass prof Gerd Sällsten and Sandra Johannesson, Occupational and Environmental Hygienists and prof Lars Barregård, specialist in Occupational and Environmental Medicine. Lars Barregård will be engaged without any cost for the project. From the Environmental and Health Protection Administration Johnny Andersson will be the leader of their part of the project.

4.3 Malmö

In Lund/Malmö Håkan Tinnerberg, PhD, and Katarina Friman, MSc, from the Department of Occupational and Environmental Medicine at Lund University Hospital, Sussana Gustavsson, PhD-

student, GIS-center Lund University and Environment and Health Protection Administration of Malmö and Petter Pilesjö, Assoc. Prof. GIS-center Lund University will be engaged.

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CV of Christer Johansson

Christer Johansson is associate professor (docent) in chemical meteorology at Stockholm university. He got his PhD 1989 at the Department of Meteorology, Stockholm university. He has a research position (universitetslektor) at the Air Pollution Laboratory of the Institute of Applied Environmental Research (Stockholm university; <http://www.itm.su.se>). He is also employed as environmental officer at the Environment and Health Protection Administration of the city of Stockholm (<http://www.slb.nu>). He has long experience of both air pollution measurements and dispersion modelling of air pollutants and has published more than 20 papers in peer-reviewed scientific journals. At Stockholm university he work as lecturer in graduate and undergraduate courses in atmospheric chemistry, biogeochemical cycles and dispersion modelling. He is currently supervisor of three PhD students and responsible for several research projects dealing with urban air pollution.

CV of Gerd Sällsten

Gerd Sällsten, has an MSc in Chemical engineering at the Chalmers University of Technology, Göteborg, and holds a position as senior hygienist at the Department of Occupational and Environmental Medicine, Sahlgrenska University Hospital. She had her PhD in 1994, and is associate professor at the Göteborg University since 1999. Her research line is exposure assessment, mainly in the areas of heavy metals and air pollution. Experienced in international collaboration in a multi-center IARC project, as well as in an ongoing EU-funded study. She is the PI of a SNAP-project on exposure to fine particles. She is the tutor of two PhD students, and has published about 50 papers in peer-reviewed scientific journals.

CV of Håkan Tinnerberg

Håkan Tinnerberg was born in 1965, obtained MSc in 1991 and PhD in 1997. His research has mainly been focusing on developing chemical analytical methods for monitoring isocyanates exposure in his thesis and in later publication he has performed and validated exposure assessments in occupational epidemiology studies. He is now involved in a study regarding the exposure to air pollution for a randomised selected population in Malmö. Håkan Tinnerberg is working as occupational and environmental hygienist and is the head of the occupational and environmental hygiene section at the department of occupational and environmental medicine at Lund University. He has been co-author to more than 20 original papers.

CV of Tom Bellander

Tom Bellander was born in 1950, obtained MSc in 1976 and PhD in 1987. His previous line of research was occupational hygiene and epidemiology (1974-1997). His current interest is in environmental epidemiology and in particular the exposure characterisation in population studies. TB holds a position as assistant director of the Unit of Environmental Health within the Department of Occupational and Environmental Medicine, Stockholm County Council, and is also associate professor at the Institute of Environmental Medicine, Karolinska Institutet, Stockholm. One of his doctorate students has obtained the doctoral degree and TB is currently the main tutor of two doctorate students. TB has repeatedly served as temporary expert at the WHO. TB has been involved in a leading role in many national and international research projects, and has co-authored more than 40 original papers.