NATUR VÅRDS VERKET

Forskningsprogram
SNAP X **REPROSAFE** **FLIPP** Inriktning: Ekonomiska styrmedel
Inriktning: Informationssystem och indikatorer IPP

Projekttitel (svensk): INTERVENT – Pilotstudie av åtgärder mot inomhusexponering för luftföroreningar som sprids utomhus

Projekttitel (engelsk): INTERVENT – Pilot study of intervention against indoor exposure to outdo pollutants

Huvudsökande

Efternamn:	Förnamn:	Födelseår:	Kvinna ☐ Man X
Bellander	Tom	1950	

Organisation:	Institution:
Stockholms läns landsting	Arbets och Miljömedicin

Adress:	Postnr:	Ort:
Norrbacka, 3 tr,	171 76	Stockholm

Telefon:	E-post:	Tjänst:
08-5177 7906	tom.bellander@smd.sll.se	bitr enhetsch (docent)

Medsökande

Efternamn, förnamn, tjänst, organisation, institution:
Nilsson, Malin, forskningsassistent (civ ing), Karolinska Institutet, Institutet för Miljömedicin

Telefon:	E-post:	Kvinna X Man ☐
08-5177 7920	malin.nilsson@smd.sll.se	

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:

Ett flertal studier har visat att uppmätta eller skattade halter av luftföroreningar utomhus är förknippade med skillnader i sjuklighet och dödlighet. Det gäller även vid de haltnivåer av luftföroreningar som är aktuella i svenska samhällen och trots att de flesta tillbringar 90% eller mer av tiden inomhus. I en tidigare studie inom SNAP (Bellander, ”Inne-Ute”, avslutas 2004) undersöks hur luftföroreningar som sprids utomhus uppträder inomhus. Resultaten kan ligga till grund för normer för vissa aspekter av luftkvaliteten inomhus. Det är dock oklart vilka möjligheter som i praktiken finns för fastighetsägare och boende att säkerställa en god inomhusmiljö i områden med höga luftföroreningshalter utomhus, och i förlängningen av detta vilka krav myndigheter kan ställa på byggnader i utsatta lägen.

Föreliggande pilotstudie syftar till att undersöka olika möjligheter till att minska inflytandet av utomhusluften på inomhusluftens kvalitet.

Den metodik som använts i det tidigare projektet kompletteras med indikatorer för dieselavgaser och vedrök, så att luftföroreningarna i inomhusluftens kan karakteriseras för påverkan från avgaser från bensin- respektive dieseldrivna fordon, fastbränsleavgaser, uppvirvlat gatudamm samt luftföroreningar från andra regioner. I ett mindre antal utsatta bostäder undersöks om påverkan från dessa källor kan minskas genom förändrad ventilation eller installation av någon form av luftrenare.

Resultaten kommer att presenteras direkt till berörda myndigheter, vid nationella och internationella konferenser samt i den vetenskapliga litteraturen.

	År 2004	År 2005
Summa sökta medel per år i kr:	1 445 040	1 617 840

Sökta projektmedel fördelade på kostnadsslag	År 2004 (kr)	År 2005 (kr)
Personalkostnad inkl. soc. avgifter *		
Tom Bellander, projektledare (10%: 0.1*2*12*1.55*40 000=148 800)	74 400	74 400
Malin Nilsson, doktorand (75%: …*25 000=697 500)	232 500	465 500
Martin Kruså, forskningsassistent (25%: …*25 000=232 500)	116 250	116 250
Ventilationsexpert, 4 månader (4*1.55*35 000=217 000)	108 500	108 500
Doktorand v. kem. an. lab, oorganisk analys, 4 mån (4*1.55*25000=155 000)	77 500	77 500
Doktorand v. kem an. lab, organisk analys, 6 mån (6*1.55*25000=232 500)	116 250	116 250
Summa personalkostnader	*725 400*	*958 400*
Övriga omkostn exkl moms (förbrukningsmtrl, analyser, resor etc)**		
Förbrukningsmaterial kemiska analyser	30 000	30 000
Provtagningsutrustning (kompl. av bef. med 6 PM1 impaktorer, 4 inomhuspumpar	200 000	
Externa analyser NOx och NO2, 100 st a 500 kr	25 000	25 000
Externa analyser SO2, 100 st a 300 kr	15 000	15 000
Externa analyser ventilationsmätning, 20 st a 5000	50 000	50 000
Resor inom Sverige och övriga Norden, 10 a 5 000	25 000	25 000
Utrikes resor, 5 a 15 000		75 000
Särtryck, 4 a 5 000		20 000
Summa omkostnader	*345 000*	*240 000*
Delsumma av ovanstående poster:	1 070 400	1 198 400
Förvaltningspåslag: .....35.... %	374 640	419 440
Totalsumma per år: (införs sid. 1):	1 445 040	1 617 840

*) 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
ALVA	SNAP/NV	2004-5	748 828	
SENSI	SNAP/NV	2004-5	830 000	830 000
AIRGENE	EU	2004-5	1 444 176	1 444 176
Luftkvalité i små barns inomhusmiljö	SNAP/NV	2004-5	1 033 000	1 033 000

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

Projekttitel	Finansiär	Tidsperiod	Beviljat Kr
ALVA	NV/Formas	2001-3	1 320 000
SENSI	NV/SNAP	2003	499 969
AIRGENE	EU	2003	979 560
Luftkvalité i små barns inomhusmiljö	NV/SNAP	2002-3	859 916
Cohort feasibility	NV/SNAP	2002-3	297 000
INDEX	VV	2000	333 333
ONSET	NV/SNAP	2002-2003	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:
Tom Bellander	Göran Pershagen

Ansökan skall bestå av detta formulär jämte högst sex sidor lång projektbeskrivning på **engelska** (strukturerad som den svenska sammanfattningen samt en redovisning av kunskapsläget). Referenser till egna publikationer ges med sifferhänvisning till CV. Andra referenser ges i löpande text. Sökandes och eventuell medsökandes CV får omfatta högst två sidor. Inga bilagor kommer att beaktas vid bedömningen. Ansökan (max 10 A4-sidor, 12 punkters teckenstorlek) skall inlämnas i **original + 15 kopior samt elektroniskt** till ansok@naturvardsverket.se. Häfta ihop ansökan och använd hålat papper. Ansökan skall ha inkommit senast den 15 oktober 2003 till Naturvårdsverket, Forskningssekretariatet, 106 48 STOCKHOLM.

INTERVENT – Pilot study of intervention against indoor exposure to outdoor pollutants

Tom Bellander, associate professor
Malin Nilsson, master of science and engineering
Martin Kruså, analytical chemist
Department of Occupational and Environmental Health, Stockholm County Council, and Institute of Environmental Medicine, Karolinska Institutet.

Background, importance

Studies of health effects from long-term exposure to air pollution have mainly been from the U.S (Dockery et al 1993, Pope et al 1995 & 1999, Abbey 1999), showing that fine particulate (aerodispersed particulate matter with aerodynamic diameter less than 2.5 μm: PM2.5) is associated with increased general mortality, in most part due to increased cardiopulmonary mortality, and to a lesser extent to increased lung cancer mortality. In the reanalysis of the two first studies (Krewski et al 2000), it was found that the important exposure contrasts are operating at very large scales, indicating that the corresponding European exposure contrasts may be the long-range transport differences rather than the local differences due to e.g. differences in traffic emissions. However, the "lung cancer in Stockholm" (LUCAS; Nyberg et al 2000) study indicated that there are within-city differences of lung cancer risk that was associated with differences in traffic-related air pollution (Bellander et al 2001) but not with local pollution from house heating (extensively by oil in that period). The latest contribution to this topic is the Dutch cohort study showing that proximity to major roads is associated with increased general mortality (Hoek et al 2002). It is thus probable that both long-distance transported air pollution and locally emitted traffic-related pollutants contribute to increased mortality.

A surprising finding in the above mentioned reanalysis project was a strong modifying effect of education: for persons with more than high-school education there did not seem to exist any association at all between air pollution and increased mortality. It is not clear what the reason might be, but it has been suggested that better educated people live and transport themselves in houses and cars that more frequently have air conditioning and perhaps in other ways are protective against the penetration of air pollutants in the spaces were people spend most of their time. If this is true, improving Swedish houses in this respect would contribute to public health.

There are some previous studies of abatement of indoor air pollution that have focussed the protection from summary categories of air pollution as eg PM10, or of asthmatics from allergen exposure, concluding that indoor sources are so strong that it is virtually impossible to decrease exposure with ventilation, vacuum cleaning or air cleaning equipment (Lecfoe & Inculet 1975, Monn et al 1997, Gore et al 2003). Protection against the types of air pollution that do not have strong indoor sources is different. Recent studies on the effect of inlet filtration or stand-alone air cleaning devices against *smaller* particles seem more promising (Richardson et al 2001, Fisk et al 2002). The limitation of the previous studies of intervention against outdoor particulate indoors is that they have not characterised particulate air pollutants from different sources. Chemical and statistical methods have been developed in the last decade, that allow the (at least partial) speciation of particulate air pollution according to source (Querol et al 2001, Zheng et al 2002, Vallius et al 2003, Cyrys et al 2003, Qin et al 2003, Harrison et al 2003), but have to our knowledge never been applied to indoor air improvement efforts.

An ongoing SNAP project (Bellander, Luftkvalité i små barns inomhusmiljö, will finish in 2004) is investigating how outdoor air pollution penetrates into indoor environments, and how it can be characterised in the indoor environment, using chemical analysis of collected particulate matter. The now proposed study will build upon this study and explore different methods of reducing the indoor levels of outdoor air pollution, both of transboundary and local origin.

The results will be helpful in developing standards for buildings in areas with high pollution levels, in particular when housing vulnerable groups as newborn, elderly, and persons with circulatory or airway diseases. The most important use of the results is however as an input to science, policymakers and industry, to further develop strategies for the protection of the general population from adverse health effects from outdoor air pollution.

Aim and hypothesis

This pilot study aims at exploring ways of decreasing the influence of the outdoor air quality on the indoor air quality. The hypothesis is that candidates of such interventions may be identified, to be studied more in detail in future projects.
The specific aims of the pilot study are:

- To establish experimental situations in which real-life buildings can be used for studying the effects of ventilation on outdoor aspects of indoor air quality.
- To establish experimental situations in which real-life buildings can be used for studying the effects of different types of air cleaning equipment.
- To implement newly developed methods for source apportionment of organic parts of particulate air pollution in these settings, in order to quantify the partial contributions from different combustion sources, eg internal combustion engines with different fuels, and house heating with different fuels.
- To investigate the relation between these partial contributions and more readily available indicators of combustion-related local pollution as NOx, NO2, CO and soot.
- To measure how indoor levels of inorganic and organic components of particulate outdoor pollution are affected by different regimes of ventilation and air cleaning.

Materials and methods

Four houses will be selected for the study. One should be in a building with essentially spontaneous ventilation in a block at a street with considerable traffic (PM10 2005 norms exceeded) and have windows facing both the street and the back. The second should be similar to the first, but equipped with completely mechanical ventilation with the possibility of filtrating inlet air. Both offices or and homes are possible. The third and the fourth will be detached homes with mechanical ventilation, one in an area with low traffic but intense wood smoke emissions, and one in an area were long-range transported pollution is dominating. All houses will be non-smoking and devoid of gas appliances or other strong indoor sources of combustion-related air pollution.

In each house four experiments will be performed: 1. baseline, 2. improved ventilation (inlet), 3. with stand-alone air cleaning (with ventilation as at baseline), and 4. both improved ventilation and stand-alone air cleaning. In order to allow for randomisation of the experimental order, the improved ventilation will be developed and implemented before the experiments. Direct reading instruments will be used at this stage, to evaluate what may be efficient improvement. The improvements will be performed in scientific collaboration with

ventilation experts. The air cleaning device will always be present and running at the experiments, with or without function.

Each experiment will last a week (or longer if necessary to ensure quantification). During the experiments, the following samples will be taken both outdoors and indoors: particulate matter as PM2.5 (on two different media) and PM1 (on two different media), NOx, NO2 and SO2. All samples will be in duplicate. The total number of sharp samples of each type will thus be at least 4 (houses)*4 (experiments)*2 (locations in and out)*2 (duplicates) = 64. With start-up sampling and field blanks we anticipate that a total of about 100 samples of each kind need to be analysed.

PM will be collected with Harvard impactors and vacuum pumps. Collected particulate will be analysed for mass, light reflectance ("soot") and chemical composition. In addition to sampling for inorganic speciation of collected particulates, we will collect samples for analysis of organic compounds that can be used for more detailed source apportionment of different types of combustion (Zheng et al 2002; Manchester-Neesvig et al 2003). Scientific collaboration will be offered to a suitable laboratory in order to keep this analytical cost at a reasonable level.

Gaseous pollutants will be collected by diffusion samplers. Ventilation rate will be monitored at all experiments.

Time plan

A detailed work plan including all collaborations will be developed in the spring of 2004. Pre-experimental field work and chemical analytical work, as well as ventilation improvements will be performed in the fall of 2004. Experiments will be performed in the winter 2004/05, chemical analysis in the spring of 2005. Statistical analysis and reporting by the end of 2005.

Personnel and budget

The project will be coordinated by Tom Bellander. Developing of work plan, all field work, gravimetric and light reflectance analyses, statistical analysis and reporting will be performed by Malin Nilsson, supported by Martin Kruså. Development and implementation of ventilation will be performed by ventilation experts (to be contracted) and the chemical analytical works by external analytical laboratories (to be contracted).

Dissemination

The results will be presented directly to authorities and industry involved, at national and international conferences, and reported to the scientific literature. Special attention will be taken to ensure a good spread of the results to a variety of arenas: policy making, ventilation, analytical chemistry, environmental health.

References

Abbey D, Nishino N, McDonnell W, Burchette R, Knutsen S, Beeson L, Yang J. Long-term inhalable particles and other air pollutants related to mortality in nonsmokers. Am J Respir Crit Care Med 1999;159:373-82.

Bellander T, Berglind N, Gustavsson P, Jonson T, Nyberg F, Pershagen G, Järup L. Using geographic information systems to assess individual historical exposure to air pollution in Stockholm County. EHP 2001;109(6):633-639.

Cyrys J, Stölzel M, Heinrich J, Kreyling WG, Menzel N, Wittmaack K, Tuch T, Wichmann HE. Elemental composition and sources of fine and ultrafine ambient particles in Erfurt, Germany. Sci Total Environ. 2003; 305:143-156.

Dockery DW, Pope CA, Xu X, Spengler JD, Ware JH, Fay M, Ferris BG, Speizer FE. An association between pollution and mortality in six U.S. cities. N Engl J Med 1993;329:1753-9.

Fisk WJ, Faulkner D, Palonen J, Seppanen O. Performance and costs of particle air filtration technologies. Indoor Air. 2002 Dec;12(4):223-34.

Gore RB, Durrell B, Bishop S, Curbishley L, Woodcock A, Custovic A. High-efficiency particulate arrest-filter vacuum cleaners increase personal cat allergen exposure in homes with cats. J Allergy Clin Immunol. 2003 Apr;111(4):2003-10-11

Harrison RM, Tilling R, Callén Romero MS, Harrad S, Jarvis K. A study of trace metals and polycyclic aromatic hydrocarbons in the roadside environment. Atmospheric Environment 2003;37:2391-2402.

Hoek G, Brunekreef B, Goldbohm S, Fischer P, Brandt van den PA. Association between mortality and indicators of traffic-related air pollution in the Netherlands: a cohort study. The Lancet 2002 Oct; 360:1203-1209.

Krewski D, Burnett R, Goldberg MS, Hoover K, Siematicky J, Jerrett M, et al. 2000. Reanalysis of the Harvard Six Cities Study and the American Cancer Society Study of Particulate Air Pollution and Mortality. Health Effects Institute Special Report, July 2000.

Lefcoe NM, Inculet II. Particulates in domestic premises. II. Ambient levels and indoor-outdoor relationships. Arch Environ Health. 1975 Dec;30(12):565-70.

Manchester-Neesvig JB, Schauer JJ, Cass GR. The distribution of particle-phase organic compounds in the atmosphere and their use for source apportionment during the Southern California Children's Health Study. J Air Waste Manag Assoc. 2003 Sep;53(9):1065-79.

Monn C, Fuchs A, Hogger D, Junker M, Kogelschatz D, Roth N, Wanner HU. Particulate matter less than 10 microns (PM10) and fine particles less than 2.5 microns (PM2.5): relationships between indoor, outdoor and personal concentrations. Sci Total Environ. 1997 Dec 3;208(1-2):15-21.

Nyberg F, Gustavsson P, Järup L, Bellander T, Berglind N, Jakobsson R, Pershagen G. Urban Air Pollution and Lung Cancer in Stockholm. Epidemiology 2000;11(5):487-495.

Pope CA 3rd, Dockery DW, Kanner RE, Villegas GM, Schwartz J. Oxygen saturation, pulse rate, and particulate air pollution: A daily time-series panel study. Am J Respir Crit Care Med 1999;159:365-372.

Pope CA, Thun MJ, Namboodiri MM, Dockery DW, Evans JS, Speizer FE, Hearth CW. Particulate air pollution as a predictor of mortality in a prospective study of U.S. adults. Am J Respir Crit Care Med 1995;151:669-74.

Qin Y, Oduyemi K. Atmospheric aerosol source identification and estimates of source contributions to air pollution in Dundee, UK. Atmospheric Environment 2003;37:1799-1809.

Querol X, Alastuey A, Rodriguez S, Plana F, Ruiz CR, Cots N, Massagué G, Puig O. PM10 and PM2,5 source apportionment in the Barcelona Metropolitan area, Catalonia, Spain. Atmospheric Environment 2001;35:6407-6419.

Richardson G, Harwood DJ, Eick SA, Dobbs F, Rosen KG. Reduction of fine airborne particulates (PM3) in a small city centre office, by altering electrostatic forces. Sci Total Environ. 2001 Mar 26;269(1-3):145-55.

Vallius M, Lanki T, Tiittanen P, Koistinen K, Ruuskanen J, Pekkanen Juha. Source apportionment of urban ambient PM2.5 in two successive measurement campaigns in Helsinki, Finland. Atmospheric Environment 2003; 37:615-623.

Zheng M, Cass GR, Schauer JJ, Edgerton ES. Source apportionment of PM2.5 in the Southeastern United States using solvent-extractable organic compounds as tracers. Environ Sci Technol. 2002 Jun 1;36(11):2361-71.

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.

CV of Malin Nilsson

Malin Nilsson was born in 1968 and obtained MSc in 1994 at the Departement of Chemical Engineering, Lund Institute of Technology. Her main interest since then has been chemical risks in the working environment. She has been working with this at IVL- the Swedish Environmental Research Institute and at AFA Insurance. Since February 2003 she is employed at the Institute of Environmental Medicine, Karolinska Institutet, Stockholm. She is investigating how outdoor air pollution penetrates into indoor environments, and how it can be characterised in the indoor environment, using chemical analysis of the collected particulate matter. Financing of the proposed study will make it possible for her to become registered as a PhD student at the Karolinska Institutet.