

**FINNISH RESEARCH PROGRAMME ON
ENVIRONMENTAL HEALTH
1998 - 2001**

EVALUATION REPORT

16.9.2002

Preface

The Finnish Research Programme on Environmental Health (SYTTY) was launched in 1997 to establish an integrated approach in the field of environmental health. The programme was a co-operation between the Academy of Finland, the National Technological Agency (Tekes), the Finnish Work Environment Fund and the Ministries of Environment, Transport and Communications, and Agriculture and Forestry (each allocating 5.1, 2.3, 0.3, 0.3, 0.2 and 0.2 million Euro, respectively), the total assets of the SYTTY programme being 8.3 million Euro.

The programme was implemented in the period 1998 – 2001 and brought together scientists from different disciplinary backgrounds into 46 research projects (see Appendix 1). The projects were divided into five theme areas. In addition, 25 projects were belonged to co-operative units of research teams (consortia).

The general objective of the programme has been to generate information for the assessment of connections between the environment and human health, and to develop procedures, methods and techniques for the promotion of environmental health. Special emphasis was put on the needs to organise scientific work on a multi- and interdisciplinary basis, to enhance co-operation among research teams, to promote research training in environmental health, and to raise the quality of environmental health research in Finland.

The Academy of Finland initiated an international review and evaluation of the SYTTY programme. Professor Helmut Greim from the National Research Center for Environment and Health, Germany; Professor Pirjo Helena Mäkelä from the National Public Health Institute, Finland; Professor Göran Pershagen from the Institute of Environmental Medicine at Karolinska Institutet, Sweden; Professor Bernd Seifert from the Federal Environmental Agency, Germany; and Professor Gert Spaargaren from the Wageningen University, the Netherlands, participated in the evaluation group. Docent Pia Verkasalo from the National Public Health Institute acted as expert secretary for the evaluation.

For the evaluation, the panel was asked to address the following set of questions in particular:

- Has the programme produced added value (compared to the regular research appropriations with no specific themes)?
- Has work in consortia brought along additional value (compared to non-consortia work) ?
- What about the scientific quality and the output of research?
- Has training of researchers been achieved?
- Has there been national and international co-operation?
- Have the results been integrated and synthesised?
- Have the objectives of the programme been fulfilled?

This publication includes the report of the evaluation group. The abstracts and other information of the SYTTY research programme are available on the National Public Health Institute's web pages at www.ktl.fi/sytty.

Helmut Greim
Professor, Chair of the Evaluation Group of the Research Programme

Background

After the SYTTY programme was launched in 1997, a total of 175 research applications were submitted. The programme committee nominated by the board of the Academy of Finland and consisting of the representatives of the participating funding agencies, selected 86 projects for the second stage. These were evaluated by an external international review panel consisting of Professor Helmut Greim from the National Research Center for Environment and Health, Germany; Dr Charlotte Braun-Fahrländer from the University of Basel, Switzerland; Dr. Erik Lebret from the National Institute of Public Health and the Environment, the Netherlands; Dr. S. Dusko Ehrlich from the Institut National de la Recherche Agronomique, France; and Professor Lars-Göran Nilsson from the Stockholm University, Sweden.

The review panel assessed both the scientific and methodological quality and the public health aspects of the applications. In addition, the panel considered the possibilities to investigate specific Finnish problems indicated by the Environmental Health Committee, and also the proposals of the Environment and Health (ENHE) Programme of the European Science Foundation. ENHE had intensively discussed the areas of research that need to be promoted within Europe and, in case of indoor air and drinking water, it had proposed to focus research on the extent and consequences of contamination by micro-organisms rather than investigating contamination by chemicals further. During the evaluation of the research proposals further emphasis was laid on a fair balance between research areas and sufficient support for “others”, to allow inclusion of attractive new topics.

The 46 research projects selected for the SYTTY programme were divided into five theme areas (only 2 projects were on other topics):

- (i) Indoor air (12 projects),
- (ii) Environmental and occupational chemicals (12 projects),
- (iii) Urban air and fine particles (8 projects),
- (iv) Drinking water and food (10 projects)
- (v) Social aspects of environmental health (2 projects).

Because an important aim of the SYTTY programme was to co-ordinate and bundle research activities within Finland, opportunities for co-operation were considered of high relevance during the evaluation process. To promote such co-operation 25 research projects were attributed to five research consortia (co-operative units of several research teams):

- (i) Moisture, mould and health (under “indoor air”: 7 projects)
- (ii) Environmental health risk of dioxins (under “environmental and occupational chemicals”: 6 projects)
- (iii) Urban air particles and health (under “urban air and fine particles”: 6 projects)
- (iv) Drinking water and health (under “drinking water and food”: 3 projects)
- (v) Microbial risks of drinking water contaminated with protozoans, viruses or cyanobacterial toxins (under “drinking water and food”: 3 projects)

In March 2000, a tentative midterm review offered to possibility to follow up the progress of research activities and also to correct possible non-focused research activities. The major conclusion was that the programme had made good progress. However, certain projects were encouraged to lay more emphasis on cooperation within the consortia; this appears to have led to a further improvement in the co-operation within the consortia.

The final evaluation of the SYTTY programme took place in May 2002 - five months after the termination of the programme - by an evaluation panel consisting of Professor Helmut Greim from the National Research Center for Environment and Health, Germany (chair); Professor Pirjo Helena Mäkelä from the National Public Health Institute, Finland; Professor Göran Pershagen from the Institute of Environmental Medicine at Karolinska Institutet, Sweden; Professor Bernd Seifert from the Federal Environmental Agency, Germany; and Professor Gert Spaargaren from the Wageningen University, the Netherlands. Docent Pia Verkasalo from the National Public Health Institute acted as expert secretary for the evaluation. The panel presented the following document.

Added value of the programme

General aspects

The initiative to launch a Finnish Research Programme on Environmental Health was most appropriate. Research on environmental health is multidisciplinary by character. Projects generally require expertise in different fields and tend to "fall between the chairs" because they are not given high priority either by medical or environmental research funding agencies. One can only speculate which of the SYTTY research projects would have been implemented through the regular Academy of Finland calls for research applications. Given this background the evaluation panel decided in this context to make an attempt to characterize the major findings and evaluate the overall success of the SYTTY programme.

The projects supported under the SYTTY programme have generated important new information for the assessment of health risks associated with environmental exposures. It is noteworthy that some central topics of the programme, such as microbial contaminants indoors and water pollution, have so far received relatively little attention internationally. In an integrated programme like SYTTY there was also a unique possibility for a comprehensive synthesis of the results to facilitate their applicability in administrative risk assessment; this issue is discussed in a later chapter of this document.

The SYTTY programme extended just over three years. This period is too short for establishing new research groups with a long-term survival potential or to produce research at the highest international standard in new areas. What can be achieved in reality is mostly to strengthen groups and projects which have already been ongoing at the beginning of the programme. A programme with funding for a longer term is required for eliciting a profound and lasting effect on Finnish research on environmental health. Such long-term national support would also be expected to generate a better competitiveness in acquiring funding from international sources.

Indoor air

The indoor part had 12 projects, of which seven belonged to a consortium. The financial input through SYTTY was around 2.4 million Euro, out of the total project funding of 3.5 million Euro (excluding the project "*Environment, decisionmaking and wellbeing - insecurity, uncertainty and crisis of experience*" which has been evaluated under the theme "*Social aspects of environmental health*"). All consortium projects dealt with microbiological contamination in indoor air. Of the non-consortium projects two dealt with microbiological problems, two others were devoted to problems of chemical indoor air contamination, and one dealt with ways to reduce the radon content of indoor air. Work for the microbiological projects extended from studying mechanistic aspects of health effects to specific health effects linked with the occurrence of microbes indoors and the remedial actions.

It is not possible at this time to exactly define the importance of the results obtained. However, it is evident that interesting results have been produced. For example, in view of the search for indicator microbes, progress has been made in ranking microbes according to their inflammatory

potential and a clearer picture has also been obtained about the role of microbial volatile organic compounds in the generation of upper respiratory symptoms. It was shown that the majority of adverse health consequences due to the presence of moulds seem to be reversible, that moisture-damaged buildings can be repaired and that a significant reduction of symptom prevalence can be achieved. In view of the reduction of emissions from products the health relevance of different volatile organic compounds has been studied successfully on patients with building-related symptoms.

Environmental and occupational chemicals

Of the 12 projects, three addressed the mechanisms and health effects of exposure to polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans (PCDD/Fs), one was on endocrine disrupters, three on occupational exposure, three on analysis and origin of environmental pollution and one analysed small area incidence of cancer. The financial input through SYTTY was around 1.8 million Euro (out of the projects' total budget of 3.7 million Euro).

The added value of the dioxin studies is the improved knowledge of the related toxic mechanism. In addition, prenatal dental development has been identified as a sensitive target for the effects of dioxin exposure. The fat-concentrations of PCDD/Fs that had effects in rats were about five-fold the typical concentrations in 20-year-old human mothers.

The studies on environmental distribution and sources of pollution as well as the incidences of hypospadias improve information on the present situation in Finland.

The added value of the occupational exposure studies is the better understanding of workers' exposure to the toxic and carcinogenic components of bitumen vapours and aerosols, as well as the information provided on exposure in waste treatment plants. Metabolism studies improved the evaluation of species differences in the susceptibility of 1,3-butadiene.

Urban air and fine particles

The consortium on urban air particles included six projects covering different aspects such as environmental monitoring, exposure assessment and health effects related to particles in air. Two additional projects on air pollution generation and monitoring were outside the consortium. The financial input through SYTTY was around 1.1 million Euro. In addition, other external funding for the projects amounted to 1.4 million Euro.

Overall the projects conformed well to the theme, important new information was obtained on population exposure to particles of different types and origin, the role of indoor versus outdoor exposure, toxicity of ambient air particles as well as on their possible effects on the cardiovascular system. While some of the results were immediately applicable for risk assessment, the relevance of other findings appeared uncertain.

Drinking water and food

There were ten projects funded under this theme (1.5 million Euro through SYTTY, 1.8 million Euro other funding), organized in two consortia – one dealing with chemical and toxicological aspects (three projects), the other with microbial contamination of drinking water (three projects). In addition, there were four projects outside the consortia, three of these dealing with microbes.

All projects were well within the theme, and most of them produced results directly relevant to the objectives of the programme. This includes new information for the assessment of connections between environment and health, and development of new or improved methods for identifying environmental health risks and improving means of their prevention. Projects highlighting the underestimated risk from brominated by-products of water disinfection, the extent of protozoal contamination of water sources, and greatly improved methods for following the chain of spread of food and waterborne infections deserve special mention. In most cases the research has been a direct continuation of what the project leader had been interested in. The programme has clearly had a large impact in encouraging the project leaders and in enabling them to initiate and carry out studies of enough ambition and researcher time to obtain significant results.

Social aspects of environmental health

Three research projects dealing with the social aspects of environmental health were included in the SYTTY programme, one on the history of the field, one on outdoor air quality and one on indoor air quality (total funding 0.7 million Euro through SYTTY and 0.1 million Euro from other sources).

The importance of the social sciences had been recognised by the SYTTY programme management, and socio-economic projects had been envisaged and invited for almost all the major themes of the programme. A special task assigned for the socio-economic sciences was to look at the ways in which environmental health issues are framed in society, how the health risks are perceived by different groups of the population and how policy-makers at different levels can respond to the problems in terms of the economic benefits and costs and the selection of policy instruments. In the end, there were high quality projects within one discipline and pieces of research that made valuable contributions to the different themes but, overall, the boundaries between the social and natural sciences turned out to be difficult to transgress and the social scientific studies did not deliver the added value on a multidisciplinary basis as it had been expected and hoped for.

Added value of the programme to Finland

During the final evaluation the following research topics and their results were identified to be of specific relevance to Finland:

- Concentrations and mechanisms of formation of trihalomethanes in water
- Causes for pollution in the Gulf of Finland
- PCDD/F exposure and health consequences
- Water contamination by protozoa, cyanobacteria and toxins, and viruses
- Mobility of herbicides in soil after different use patterns
- Determination of moisture damage in buildings and exposure
- Prevalence of mould allergy
- Characterization of size, mass, sources and distribution of particles in ambient air
- Seasonal variation of particle concentrations indoors and outdoors

Work in consortia

Overall it can be observed that consortium work within SYTTY has proved to be very beneficial. A much higher degree of synergism was achieved through working in consortia than through working projectwise and exchanging results only after the completion of each project. The added value brought in from such multidisciplinary work cannot be overestimated. In the following there are some consortia-specific remarks:

Consortium: Moisture, mould and health

Work of the consortium "*Moisture, mould and health*" has proven to be extremely effective. Out of the various consortia established within SYTTY this consortium has shown the highest effectiveness with six consortium seminars and two additional seminars organised with colleagues from Denmark. Furthermore, a consortium board had been formed which has met 11 times and created a "democratic spirit" which is very likely to have fostered collaboration. The presentations of their results by doctoral students in the seminars has probably had an educational effect in addition to the "simple" effect of exchanging research results.

The added value of consortium work is especially visible for research in the indoor domain where in most cases no single academic discipline is able to provide an answer to the pertinent questions. Consortium work also addressed the point of practical applicability more in depth, especially the intervention project concerning mouldy school buildings and that on possibilities to monitor the success of repair measures (in particular the projects "*Schools, mould and health – an intervention study*" and "*Development of methods to monitor the success of repair measures*"). It is clear that these projects have not given answers to all pertinent questions, but they have produced good approaches.

Consortium: Environmental health risks of dioxins

The work on dioxins was efficiently co-ordinated with beneficial consequences for the design of experiments and interpretation of the results. The "*Environmental health risks of dioxins*" consortia projects addressed a heterogeneous group of topics, covering the fields of environmental chemistry, molecular biology, toxicology, exposure biomarkers, and human reproductive health; it remains unclear to which extent the multidisciplinary nature of the consortium affected the more "one-single-discipline" oriented work within the individual research projects. The work of five (out of six) consortium projects continues currently in EU-funded international research projects.

Consortium: Urban air particles and environmental health

There has been some collaboration between certain study groups engaged in the consortium, such as in the EXPOLIS and EXPAND projects. However, overall the collaboration between the different groups in the consortium seems to have been limited. For example, some of the groups

worked on similar topics such as air sampling and *in vitro* studies of particle toxicity but no collaboration between these groups was indicated in the report. During the closing symposium it became apparent that some collaborative projects had been initiated between groups in the consortium, but future development is dependent on additional external funding.

The consortium had three meetings during the programme period and organised one course. It would have been useful had there been more contacts between researchers covering different aspects of air pollution, such as ambient air monitoring, exposure assessment and health risk evaluation. For example, a concluding symposium could have integrated the findings generated by the SYTTY programme in the field of particles and health, particularly in relation to risk assessment and strategies for prevention of adverse health effects.

Consortia: Drinking water and health and Microbial risks of drinking water contaminated with protozoans, viruses or cyanobacterial toxins

The heterogeneity of the projects under the theme of drinking water and food has meant that the research groups in many cases (as shown for example by the large number of projects not belonging to the consortium, although their methods and aims would clearly have been within the consortium's theme) have seen little reason to cooperate. However, especially the microbial risk projects have clearly benefited from the consortium, e.g., in the organization and selection of sample collection. However, additional aspects of their work could have benefited from their co-operation, e.g., joint work planning and evaluation of results.

Scientific quality and the output of research

The projects have in general produced a large amount of good quality research. The number of articles published in international peer-reviewed journals reported by all the groups funded by the SYTTY programme is 188 (on average 4.1 articles per project, ranging from 0 to 38), including many in foremost journals of the field in question. The real output will clearly be considerably larger since it will certainly take several more years before all results of the three years of work have been digested and written in a form that does them justice. After the official end of a research programme funds should be made available to carry out these final analyses and reporting.

Indoor air

The research projects are adding to our knowledge of all, analytical aspects (how to measure and what to measure), health effects, mechanistic aspects concerning health effects, and likelihood of success of control measures. These results are useful both at the scientific and - which is an important aspect of research on the indoor environment - at the practical level, although it is clear that the degree of direct applicability of these results for public health purposes varies.

Environmental and occupational chemicals

The scientific quality and the output are very good. Of the 90 contributions to international and peer-reviewed journals 45 dealt with male reproductive health and environmental endocrine disruption, 23 were on environmental pollution, six on occupational health and three on small area analysis of cancer incidence.

Urban air and fine particles

The scientific quality of the different projects in the theme varied. The two projects with the most extensive production during the SYTTY programme received substantial funding from other sources, such as the European Union. These projects have generated several interesting publications on the cutting edge by international comparison. In general, these projects were ongoing when the additional funding from SYTTY became available. It is clear that the funding from SYTTY has contributed to the success of these projects, although the specific effect of the SYTTY funding is difficult to assess. On the other hand, two other projects received substantial financial contributions from the SYTTY projects but limited support from other sources. These projects have not yet generated any original publications in international journals, which may partly be the result of the later start of these projects. However, it also suggests that other sources of funding are vital for the success of the projects.

The SYTTY programme has contributed to the development of research in Finland related to urban air and fine particles. This is one of the most active areas of research in environmental health and the focus is excellent. Some of the groups supported by the programme have a strong

international reputation and continue to be productive, for example the groups working on individual exposure assessment and air pollution epidemiology. For future funding it seems reasonable to prioritise such groups instead of distributing funding to many groups of varying quality. Some aspects of air pollution have received only limited attention in the programme, such as the role of modern diesel engine technology and health effects related to wood burning. This deserves a higher priority in the future.

Drinking water and food

Most of the projects have produced new scientific knowledge and developed methods and procedures for better surveillance of health risks associated with drinking water or food. In many cases the survey data produced are of direct relevance to Finland as well as of importance to the general understanding of the role of drinking water and food in outbreaks of disease. The importance of this research is reflected in the publication of many research reports in the highest-ranking journals of the field.

Social aspects of environmental health

The historical projects "*Health, environment and social change in Finland 1750 – 2000*" produced results of good scientific quality. They were able to document the history of environmental health problems in Finland in a detailed way, and provided insight in the ways in which environmental health problems were framed in earlier periods. The scientific output of the historical projects seems to be satisfactory. The contribution to the overall programme of SYTTY was restricted by the fact that the historical studies were conducted from the perspective of one single discipline. It would have been a major contribution if the results from the historical studies were presented and discussed in their relevance for understanding the present-day (changes in the) discourses on waterborne diseases and air -pollution as well as with respect to the modern way of dealing with risks.

The research project which was aimed to contribute to the consortium theme of indoor air quality – "*Environment, decision making and well being, insecurity, uncertainty and the crisis of expertise*" – was well chosen with respect to the research topics dealt with and the methodologies applied in the research. The potential for generating additional value for the programme by working on a multidisciplinary basis, could be considered very high. The results from these projects cannot yet be estimated because these projects have not yet presented full reports or scientific articles. From the description of the results as available one can conclude that it is important to enhance the technical scientific assessment of mould and moisture problems in public buildings by information on the perception of these problems by school-pupils and the residents and also to estimate the ways in which local authorities and decision-makers deal with these problems.

The research project(s) aimed at contributing to the consortium theme of outdoor air quality, - "*Housing, urban structure and health*" – combined sociopsychological theories and methodologies with a sociological perspective on the framing of urban health issues by both

(expert) policy makers and the (lay-actor) residents. Again, the potential for contributing to the overall discussion in the outdoor-air consortium seems to be high, because issues of (the perception and valuation of) spatial density and traffic intensity can be directly related to (measured levels of actual) air pollution. Based on the preliminary results, the researchers claim that (in addition to the actual levels of pollution) individual and situational factors are very important in determining the perception of and the ways of dealing with urban health issues. Whether this claim is substantiated in a scientifically solid way can be determined, when the reports and articles on these projects are made available.

Training of researchers

One of the high quality features of SYTTY has been the successful training of young scientists to become more familiar with important and growing research areas. Between January 2000 and January 2002 the number of degrees gained in SYTTY projects has amounted to 11 doctoral degrees, 14 master's degrees and two licentiate degrees. However, it is too early to assess the final result of the programme and it is indicated that several academic theses will be defended within the next two years.

It is probable that the contacts between junior researchers in doctoral programmes, who meet in courses or at seminars (see chapter "*National and international collaboration*"), will lead to a better mutual understanding of different types of research as well as to new ideas and collaboration in the future. The SYTTY programme has generated a critical mass of students for organising courses which would otherwise have not taken place.

It should be noted that the training has also included an important, though often neglected, aspect of scientific work, namely to learn how to present research findings. There is no doubt that the obligation to present results at seminars, workshops and conferences, and to write journal articles has added to the training effect.

In addition, it is very likely that the multidisciplinary nature of the work has also contributed to the training of the participating professionals in areas with which they have been less familiar before.

The number of young researchers in the projects is impressive and shows the impact of the programme in attracting and training young people in the field of environmental health in Finland. However, such training is mostly achieved within the experimental work of a doctoral thesis. Although time for the specific training depends on the complexity of the experimental skills needed, experience indicates that a three years term is often too short to complete a sophisticated training and research programme.

National and international collaboration

It is difficult for someone standing outside the different research groups to assess the real extent of co-operation both within a group and among groups of researchers. Also, in many cases co-operation had been initiated before the start of the SYTTY programme, and it is not clear to what extent SYTTY has facilitated additional collaboration. Despite such reservation it seems that the organisational structure of SYTTY has been successful in fostering national co-operation further. This is especially noteworthy for the SYTTY coordination-organized symposia and meetings as well as for the work in the consortia, which have regrouped scientists from many different research institutions and also from private companies, which is important in view of the role of practical applicability of the results.

When assessing the extent of international co-operation, it must be borne in mind that SYTTY was a national research programme, primarily with the intention of promoting national research (which may, nevertheless, have been a part of an international collaboration and naturally of general interest). It is noteworthy that the SYTTY coordination organized three two-day programme symposia each with over 100 participants. These symposia served as occasions to screen the work of projects, but also as a forum to meet other researchers. They were attended by SYTTY-researchers and other interested parties and offered the doctoral students an excellent opportunity to give presentations either orally or as posters. For each symposium a proceedings book with research results was published. Moreover, the SYTTY coordination also organized four international *Gordon-conference* type meetings. In these, doctoral students, their tutors and established international scientists (between five and eight in each conference, 25 altogether) were invited together for several days to the remote *Valamo monastery*. The meetings were in accordance with the themes of SYTTY, and were focused differently each year. There were 60 to 70 participants in each conference.

Otherwise, it was left to the initiative of individual researchers to organise collaborative work and other types of contacts beyond Finnish borders. For example, in the indoor air part of SYTTY this was achieved in a number of cases by direct co-operation with researchers from Denmark, France and the U.S.A. Also, the bilateral workshops with Denmark on "*Moulds in Buildings*" organised by the "*Moisture, mould and health*" consortium should be mentioned, as should be the invitation of international speakers to the some of the consortium's seminars. International collaboration was also intense for some groups in the consortium "*Urban air and fine particles*", particularly with leading centres in Europe. In addition, there are now 15 EU projects that continue the work of the SYTTY projects.

It can be assumed that besides such direct involvement of foreign researchers SYTTY has generally fostered contacts with the members of the international research community, be it at international conferences and working groups, or in bilateral discussions. It is obvious that these contacts have made the Finnish results available to the international research community and have thus also been of great value to researchers outside Finland.

Integrating and synthesising the results

At this point, five months after the termination of the SYTTY programme, it is not yet possible to evaluate exhaustively the success of the integration and synthesizing of the research results and their communication to policy makers and lay persons. We can only give our impressions based on the known efforts for dissemination of knowledge and their expected impact.

To disseminate knowledge of the research results the SYTTY coordination organized four one-to-two-day seminars for end users of knowledge (e.g. state and community authorities). A total of 13 press releases and eight press conferences disseminated to communicate the results of individual studies.

So far results of the SYTTY programme have been collated and published as three theme numbers of two Finnish-language journals (*“Ympäristö ja terveys”* and *“Sisäilmauutiset”*) which are targeted to for end users of knowledge and any (lay) person interested in reading about the results; a fourth Finnish-language special issue (a supplement number) is currently under the process of publication. The articles have been written by researchers and their topics range from indoor air to moisture damage and small particle research, drinking water, chemicals and food. In addition, the *“Urban air particles and environmental health”* consortium has prepared a supplement number to a peer-reviewed journal (*“Scand J Work Environ Health”*) with 11 peer-reviewed articles on varying aspects of multidisciplinary research on urban air particles in Finland.

Thus, research within the consortia *“Moisture, mould and health”*, *“Urban air particles and environmental health”* and *“Environmental health risk of dioxins”* has certainly contributed to integrate at least part of the work within the duration of the SYTTY programme. In several other fields and especially in the case of many non-consortia projects, efforts at such integration are not clearly visible.

For each theme or consortium full integration and synthesis of the results should be undertaken after all work has been completed and evaluated. This task may be performed by a small group of senior researchers together with the coordinators of the consortia. The task should include discussions of the results, their applicability for technical measures, risk analysis and (if necessary) risk assessment.

Fulfillment of the aims of the programme

The two major objectives of the SYTTY programme were to generate information for the assessment of connections between the environment and human health, and to develop procedures, methods and techniques for the promotion of environmental health. Special emphasis was put on the needs to organise scientific work on a multi- and interdisciplinary basis, to enhance co-operation among research teams, and to promote research training in environmental health.

The SYTTY projects have in general produced a large amount of good quality research. The work in co-operating units of research teams (consortia) proved to be very beneficial. The organisational structure of SYTTY was successful in fostering national co-operation, symposia and meetings, and in training of young scientists.

For indoor air, and environmental and occupational chemicals, the intentions of the programme have widely been fulfilled. This concerns all aspects discussed above.

For urban air and fine particles important new information has been generated on the association between such exposure and adverse health effects. The theme included projects from several disciplines. However, the collaboration between research teams in most projects appeared rather limited, and not taking full advantage of the multidisciplinary character of the theme.

For drinking water and food, major objectives have been met very well and in a balanced way within this theme areas so that methods development and evaluation has been a starting point for their application in surveillance of health risks. The results are directly relevant to Finland as well as of general international interest. Altogether, the quality of research on drinking water and food in Finland has been improved.

With respect to the inclusion of social aspects of environmental health, as the programme director stated during the closing symposium, the programme turned out to be somewhat “ahead of its time”. There were some high quality disciplinary projects and some pieces of research made valuable contributions to the different themes but, overall, it turned out to be rather difficult to include enough projects and people from the socio-economic sciences who were both willing and able to make a contribution on an interdisciplinary or at least multidisciplinary basis.

An overwhelmingly important aspect of research output in applied activities such as the SYTTY programme is to ensure that the results not only reach the scientific community but also the risk assessors and people engaged in health protection on various levels as well as in regulatory agencies. The SYTTY coordination has made excellent work to contribute to this aim by organizing several seminars to both scientists and practical end users of knowledge, and by facilitating the publication of at least four theme numbers in journals aimed at lay persons and policy makers.

In the future, even more emphasis should be placed on the dissemination of information to decision makers and general public. A more prominent and extensive contribution from social scientists could be expected to extend the knowledge base and success of risk analysis and

communication. The task force outlined under the chapter “*Integrating and synthesising the results*” might also prove helpful towards deepening this aspect.

Recommendations

1. Strengthen work within consortia

The review panel noticed that the consortia with extensive coordination of research activities achieved the most appropriate quality of research, interpretation of data and their applicability. Much of the efficacy of consortium work relied on the coordinator. The review panel recommends to specifically sponsor research projects within consortia and to emphasize appointment of a capable coordinator also in the future programmes of the Academy of Finland.

2. Extend research programmes beyond three years

One of the major aims of research programmes is training of young scientists. This is mostly achieved while working for a doctoral thesis. National and international experience indicates that this can be barely achieved within three years. It is also to be considered that a new research programme requires hiring of additional personnel. Time for the specific training depends on the complexity of the skills needed. This means that efficient research starts at the beginning of the 2nd year leaving only two years for efficient research including preparation of the report. The review panel strongly recommends extension of research programmes beyond three years. Two two-year -periods with interim evaluation is seen as one possibility.

3. Encourage and support exchange within Europe

The review panel fully agrees that the criteria for co-operation are based on shared scientific interests. In addition to the traditional co-operation with research institutes in North America, contacts to research institutes within Europe should be improved. Incorporation of exchange programmes for young scientists should be included in the general aims of the research programmes of the Academy of Finland.

4. Improving applicability of research results in the study design phase

The review panel proposes that consideration of applicability of the results be given as early as in the study design phase. This also includes the assessment of dose-response relationships, even in mechanistic studies *in vitro* and *in vivo*. A thorough and detailed assessment of exposure, preferably using quantitative information based on measurements and/or modelling, greatly enhances the applicability of results from epidemiological studies and integration of results from different disciplines.

5. A specific task force to integrate and disseminate the results

In all research programmes such as SYTTY it is clear that information about the scientific results and their significance needs to reach the scientific community and also the risk assessors, regulatory agencies and politicians. Full integration and synthesis of the results should be undertaken after all work has been completed and evaluated. This task may be performed by a small group of senior researchers together with the co-ordinators of the consortia after research has been completed. The task should include discussions of the results, the applicability for

technical measures, risk assessment and (if necessary) risk management. Since such activities require extra time and funding appropriate financial support for such activities within a programme is recommended.

6. Strengthen research on socioeconomic aspects of environmental health

The SYTTY programme encouraged applications in this important and upcoming research area which addresses the response of public and policy makers to possible threats to the environment and to human health as well as the ways in which these threats are framed by lay people and by experts. Unfortunately, only few applications concerning socio-economic aspects of environmental health were submitted. The review panel strongly supports further attempts of the Academy of Finland to strengthen this area of research.

7. Increase cost effectiveness of funding

Several groups supported by the SYTTY programme had a strong international reputation and continued to develop well with the SYTTY support. In general these groups had additional external funding which contributed to their high productivity. For future programmes it is reasonable to give higher priority to such groups rather than to distribute funding to many groups of varying quality and expertise.

Appendix 1: The SYTTY research projects by theme and consortium

THEME: INDOOR AIR

Consortium: Moisture, mould and health (Aino Nevalainen)

Mechanisms of adverse health effects of mouldy house microbes: in vitro and in vivo studies on toxic effects and inflammatory responses

Maija-Riitta Hirvonen, National Public Health Institute

Exposure to bioaerosols

Aino Nevalainen, National Public Health Institute

Schools, mould and health - in intervention study

Aino Nevalainen, National Public Health Institute

Development of methods to monitor the success of repair measures

Aino Nevalainen, National Public Health Institute

Neurotoxic effects of microbial toxins

Kai Savolainen, Finnish Institute of Occupational Health

Biological activities of the metabolites of microbes present in the indoor air

Atte von Wright, University of Kuopio

Environment, decision-making and wellbeing - insecurity, uncertainty and crisis of expertise

Aulikki Nissinen, University of Kuopio

Non-consortium projects

Radonsafe foundation, moisture prevention and air exchange in a healthy building

Hannu Arvela, Radiation and Nuclear Safety Authority

Adsorption, desorption, and chemical reactions in the particulate matter collected on air filters and ducts

Pertti Pasanen, University of Kuopio

Fungal allergens and antigens - their characterization and biological effects in mice after inhalation exposure

Anna-Liisa Pasanen, University of Kuopio

Indoor air quality control

Kristiina Saarela, Technical Research Centre of Finland

Mould and moisture transfer in building structures and buildings with particular regard to the prevention of health hazards

Olli Seppänen, Helsinki University of Technology

THEME: ENVIRONMENTAL AND OCCUPATIONAL CHEMICALS

Consortium: Environmental health risk of dioxins (Terttu Vartiainen)

Developing tooth as an indicator of an organ model for dioxin exposure

Satu Alaluusua, University of Helsinki

AH receptor structure and dioxin sensitivity

Raimo Pohjanvirta, National Public Health Institute

Male reproductive health and environmental endocrine disruption

Jorma Toppari, University of Turku

Sedimentation, transport and fate of organic pollutants in Gulf of Finland

Terttu Vartiainen, National Public Health Institute

Analysis of PCDDs and PCDFs in contaminated soil and sediment using supercritical fluid extraction

Terttu Vartiainen, National Public Health Institute

Determinants of sensitivity to dioxin-induced health effects

Matti Viluksela, National Public Health Institute

Non-consortium projects

The occupational hygiene in waste treatment plants using state-of-the-art technology

Kari Hänninen, University of Jyväskylä

The possible risks of gene technology to the environmental health - the impact of herbicide resistance on the herbicide use in sugarbeet cultivation

Juha Kämäri, Finnish Environment Institute

Phytoremediation of metal polluted soils: mechanisms and manipulation of metal tolerance and hyperaccumulation in plants

Sirpa Kärenlampi, University of Kuopio

The molecular dosimetry of an environmental carcinogen 1,3-butadiene, a model compound for human risk extrapolations

Kimmo Peltonen, Finnish Institute of Occupational Health

Small-area analyses of cancer incidence around a point source

Antti Penttinen, University of Jyväskylä

Environmental and occupational health risks of recycled materials in asphalt production
Asko Saarela, Technical Research Centre of Finland

THEME: URBAN AIR AND FINE PARTICLES

Consortium: Urban air particles and environmental health (Juhani Ruuskanen)

Elemental analysis and source apportionment of personal PM_{2.5} exposure: Application of Expolis PM_{2.5} filters and data (EAS-Expolis)
Matti Jantunen, National Public Health Institute

The effect of surface properties of mineral dusts on their ability to induce inflammatory response in the lungs
Matti Klockars, University of Helsinki

Development of a population exposure model, using atmospheric dispersion modelling together with measured concentrations and personal exposures - EXPAND
Jaakko Kukkonen, Finnish Meteorological Institute

The relationship between aerosol concentrations in indoor and outdoor air and transport from outdoor to indoor
Markku Kulmala, University of Helsinki

Effects of fine and ultrafine particles on respiratory and cardiovascular health
Juha Pekkanen, National Public Health Institute

Toxic effects of urban air and diesel exhaust particles on the respiratory tract (PAMTOX)
Raimo Salonen, National Public Health Institute

Non-consortium projects

Transformation and assessment of exposure to organic compounds in combustion derived fine particles
Taisto Raunemaa, University of Kuopio

Urban PM₁₀ and PM_{2.5} concentrations in Finland and traffic related exposure to small particles
Taisto Raunemaa, University of Kuopio

THEME: DRINKING WATER AND FOOD

Consortium: Drinking water and health (Pertti Martikainen)

Chlorinated impurities in drinking water - mutagenic compounds and the mechanisms of cancer

Hannu Komulainen, National Public Health Institute

Microbially available phosphorus in drinking water

Pertti Martikainen, University of Kuopio

Brominated disinfection by-products: formation and control during drinking water disinfection

Terttu Vartiainen, National Public Health Institute

Consortium: Microbial risks of drinking water contaminated with protozoans, viruses or cyanobacterial toxins (Marja-Liisa Hänninen)

Cryptosporidium parvum and Giardia lamblia in Finnish environment and as risks for human health from contaminated drinking water

Marja-Liisa Hänninen, University of Helsinki

Cyanobacterial toxins - occurrence and levels in raw water sources and removal in waterworks

Kirsti Lahti, Finnish Environment Institute

Waterborne virus infections

Carl-Henrik von Bonsdorff, University of Helsinki

Non-consortium projects

Impact of high water fluoride on health, a preliminary study

Markku Larmas, University of Oulu

Undesirable microbial biomass in drinking water distribution system

Mirja Salkinoja-Salonen, University of Helsinki

Food associated listeriosis, yersiniosis and botulism: new DNA-based methods for studying the infection routes, controlling the spread and assessing the risks in food production

Hannu Korkeala, University of Helsinki

Hazard of animal shigatoxic Escherichia coli for human health.

Sinikka Pelkonen, National Veterinary and Food Research Institute

THEME: SOCIAL ASPECTS OF ENVIRONMENTAL HEALTH

Health, environment and social change, Finland 1750-2000

Pertti Haapala, University of Tampere

Housing, urban structure and health

Rauno Sairinen, Helsinki University of Technology

THEME: OTHER

Immunosuppressive, carcinogenic and metastasis-related effects of solar UV radiation
Christer Jansén, University of Turku

Fetal environment and early life factors and the development of asthma and allergy
Juha Pekkanen, National Public Health Institute