

Final report

COST Strategic Workshop

Health and the Natural Outdoors

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May 2007

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Executive summary

There is a convincing evidence base that confirms the benefits to human health and well-being of close contact with nature, animals and plants.

A COST Strategic Workshop was held in April 2007 in Larnaca, Cyprus. Its purpose was to identify the extent of knowledge in this field and the implications for policy and for future research. The Workshop found that nature-based approaches can contribute significantly to health objectives in Europe by ensuring that people have contact with nature in their everyday lives and that nature would be an integral feature of health care environments and approaches. More effective coordination and communication of existing knowledge and understanding, combined with increased investment in new research, is necessary to capitalise on the benefits of nature-based approaches.

Key findings from the workshop:

- There is evidence of **substantial economic benefits** arising from lower rates of illness and a reduced requirement for medical interventions. Because of the potential scale of the savings a concerted, Europe-wide effort to understand the costs and benefits is called for.
- Access to nature should be considered in **public health policy in Europe**. There are examples of national custom and national practice that could be adopted more widely.
- Access to nature and natural places can be a central theme in promoting contemporary **lifestyle-based public health approaches**.
- A **more persuasive evidence base** is needed on the links between natural outdoor environments and human health and wellbeing. Studies should investigate the mechanisms at work, and look at effects for different target groups.
- Questions about health deriving from contact with nature should be incorporated into **national health surveys**.
- Health should be a **central theme in urban and land-use planning**, for example, in debates about urban densification. Effort spent in developing tools and strategies that integrate healthy lifestyles into urban planning and greenspace management will be well repaid.
- New research should be based on a more **comprehensive catalogue of existing studies**. Substantial research has been carried out, but it is widely dispersed. Findings need to be cross-referenced, for example, against other health care and epidemiological research.
- Future research requires **common theoretical frameworks and more robust methodologies**. Some high quality studies now exist, but broader application of more rigorous methods will lead to greater acceptance in medical and related fields. Common frameworks, definitions and methodologies will enable cross-border comparisons.
- More knowledge is needed about **health-related products and commodities from nature**. Multidisciplinary work should cover the process from identification of promising substances to their commercialisation.
- The **therapeutic and mainstream application of human contacts with wild and domesticated animals and plants** is under-researched relative

to the potential benefits. The processes at work are not properly understood.

- **Cross-sectoral, multidisciplinary research** is needed. Areas for future research include the health benefits of outdoor environments, as well as issues such as food security and quality, and environmental protection.
- As research on the health effects of the natural outdoors is still dispersed, **international networking and collaboration** should be strengthened. COST and the EU's Seventh Framework Programme are among the suitable platforms for this endeavour.

Foreword

By Sjur Baardsen

Chairman of COST Domain Committee for Forests, their Products and Services

This report is one of the outcomes from a Strategic Workshop held in Cyprus during April 2007. This workshop aimed at increasing scientific knowledge on the actual and potential contributions of forestry and agriculture to health and quality of life. Until recently, this important topic was often overlooked. On behalf of COST Domain Committee for Forests, their Products and Services, I was therefore very pleased with this initiative from its very start. Looking back at the successful event, the organisers have all reasons to be proud of the arrangement and its outcome.

COST is the acronym for the organisation of *European Cooperation in the field of Scientific and Technical Research*. It is characterised by funding coordination through networking of nationally funded researchers and research projects, typically in so-called COST Actions. COST is pan-European and multidisciplinary and it follows a bottom-up approach. In its networking COST complements other funding sources at the European, as well as at the national level. Apart from its Actions, COST also applies other instruments. These include Strategic Workshops, events which provide the opportunity to develop relations to the scientific community and beyond. One or more COST Actions can interact with experts from the scientific community and from elsewhere in society to address an actual topic and enhance collaboration. The instruments applied by COST are thus very well suited for networking within research which would otherwise easily have been fragmented. Research on the role of forests and agriculture for health and human wellbeing forms an excellent example of a topic which has benefited from COST networking.

COST is funded by the European Commission. The Commission's Seventh Framework Programme for Research and Technical Development gives a high priority to health research. This is also reflected in national research priorities, and I think we will experience even more emphasis on this issue in the years to come. This means that the need for networking within health research will increase in the future. COST will remain the main provider of the tools to satisfy this need.

This workshop was initiated by the COST Domain Committee for Forests, their Products and Services, and has been further developed and planned in collaboration with the Domain Committee for Food and Agriculture. It is well rooted in two running COST actions sorting under these two domains, respectively. Therefore, this particular initiative also offers a very good example of how a COST Strategic Workshop should be developed.

This final report was compiled by workshop chairman Kjell Nilsson, workshop facilitator Chris Baines, and Cecil Konijnendijk. I would like to express my gratitude to the chairman and to the two co-editors for their invaluable efforts. Finally, I would like to thank the session chairpersons,

rapporteurs and all participants for their contributions to this successful workshop, and Christos Gallis and the Cypriot hosts for the hospitality and excellent practical arrangements.

Introduction

Background

Traditional medical and public health approaches to illness and health are among the successes of modern science. However, society today is faced with the increasing incidence of various forms of poor health related to modern lifestyles. Contributing factors include an increasingly sedentary population, increasing levels of psychological stress related to urban living and contemporary work practices, and exposure to environmental hazards such as air pollution. In addition people with disabilities and chronic illness demand a transition from institutional care to care in society. These problems encourage thinking about alternative ways to prevent disease and promote health. Lack of physical activity and stress, for example, have led to increased occurrence of certain diseases where medication is perhaps only reducing the symptoms rather than combating the true causes of illness and reduced quality of life. Efforts to promote public health and wellbeing in Europe have thus become increasingly complex.

Natural outdoor areas and natural elements such as forests, trees, gardens, farms and animals are known to provide opportunities to enhance public health and wellbeing. For example, activities in natural outdoor environments are intuitively known to be good for mental and physical health. But we lack knowledge on many aspects of this positive relationship between nature and health. What are the precise effects and mechanisms? Which outdoor environments or interactions with plants or animals work best for whom? The structured, empirical knowledge that exists has accumulated slowly, developed by research groups in disciplines as diverse as environmental psychology, landscape architecture, forestry, and epidemiology, and without the wealth of resources so commonly made available to research in medical fields.

During April 19th-21st 2007, a COST Strategic Workshop was held in Larnaca, Cyprus to address the topic of “Health and the Natural Outdoors - Research needs to promote human health”. The main *objective* of the workshop was to develop and make visible potential COST research activities which can be complementary to the plans and activities of the European Commission. A main aim was to increase knowledge on the actual and potential contributions of forestry and agriculture, respectively, to health and quality of life.

Participation

The Strategic Workshop was jointly organised by COST Actions E39 “Forests, trees and human health and wellbeing” and 866 “Green care in agriculture”. The Domain Biomedicine and Molecular Biosciences was also involved. Approximately 60 researchers from 20 European countries participated in the workshop. Participants also included the World Health Organization (WHO), the European Commission (EC), the International Union of Forest Research Organisations (IUFRO), representatives of the Cypriot government and the COST Secretariat.

Plenary talks

The first part of the workshop consisted of introductory and plenary talks. Participants were made familiar with COST, its previous Strategic Workshops on the related topics of 'Food and Health' and 'Environment and Health', WHO's activities within the topic of human health in urbanised societies and a IUFRO Task Force on forest and health interlinkages.

Workshop sessions

Key themes within the topic of health and the natural outdoors were addressed in six parallel workshop sessions. These had the following themes:

1. Health related products from natural sources
2. Human-animal interactions and green care
3. Therapeutic interactions: plants and landscapes, garden therapy and ecotherapy
4. Land use, accessibility to green areas and health effects
5. Settlements and localities: health and nature where we live
6. Health policies and economics

Each parallel workshop session comprised an introductory speech by the chairperson, followed by a keynote presentation and several shorter talks. Several of the themes had overlapping concerns; this was especially the case for workshop sessions 4 and 5 on land use and accessibility respectively nearby nature.

Developing research

Findings and recommendations from the parallel workshop sessions were reported upon in a plenary session. During this session, all information was compiled and discussed and future steps were identified for research, research policy, and policy more generally.

The Strategic Workshop stressed the need for greater awareness and knowledge of the salutogenic effects of the natural outdoors on human health and environment. Although interesting research was presented during the various sessions, it also became clear that knowledge on many aspects is still very limited. The limited amount of solid evidence also hampers collaboration with medical and other fields, as well as policy implementation.

The role of COST

The workshop demonstrated once again that COST represents a key opportunity for developing the kind of network research which will produce the biggest returns, and an opportunity for developing enhanced dissemination. Especially in the case of new, poorly coordinated research fields, COST can help bring together the key experts from different disciplines.

Main findings of the workshop

A new perspective on human health and wellbeing

Public health and modern medicine are continuously making progress in fighting diseases and ill health. However the majority of all causes of ill health, disease and premature death in the EU cannot be explained from simple relationships, such as proximity to pathogenic bacteria or genetic factors. An increasing number of future health hazards relate to our lifestyles, which are more sedentary, more stressful, and increasingly oriented indoors. A large part of the population is overweight and many diseases are related to this. Depression and pain are in greater focus, as they have a major impact on the number of years lived in good health.

There is a growing awareness of the multiple linkages between health and its various determinants, at individual as well as population level. The need for and value of intersectoral action between health and other sectors is increasingly recognised in Europe. It is also recognised that the complex nature of many health determinants and their interplay with social factors require more multi- and interdisciplinary efforts. Politicians and citizens seem to be increasingly attracted to a broader concept of health, which incorporates wellbeing and the quality of life.

Healthier societies offer potential long-term social and economic benefits and are therefore a main aim of international and national policy makers. Strategies for health-friendly decision making are led by organisations such as the World Health Organization (WHO). Apart from concentrating on special target groups, such as children, these strategies reflect more focus on prevention and thus take a more proactive stance. More attention is given to factors that determine health instead of diseases themselves. New health strategies look at the full magnitude of health effects and their distribution across the population, contrasting this distribution with the allocation of benefits.

Two previous COST Strategic Workshops looked at the linkages between Health and Environment (event held in 2005) and Food and Health (held in 2006). The Health and Environment workshop primarily looked at (potential) negative environmental impacts on health, such as the effects of toxic substances and health risks associated with exposure to pollutants. The workshop stressed, amongst others, the need for more knowledge about these effects, as well as more understanding of which parts of the population are most at risk. The strategic workshop on Food and Health discussed ways to find optimal nutrition, for example to prevent diseases and promote overall quality of life. Obesity and other food-related conditions, which are often related to dietary monotony, were in focus.

While both previous workshops provided valuable inputs to understanding the relationships between environment, food and health, various aspects of the relationships between nature and health remained largely unexplored. The previous workshop on environment and health focused on negative effects of environment on health, while positive (or: salutogenic) effects were little discussed. Yet there is a very long-established view that personal

contact with plants, animals and natural green surroundings can benefit human health and wellbeing. The importance of this is being seen as increasingly important as the human habitat becomes more urbanised. These interactions may have been somewhat overlooked so far in the public health debate, perhaps partly because of lack of awareness and of hard evidence on effects and mechanisms at work. The range of different public health benefits is wide and varied and their full extent needs to be better understood and more effectively communicated.

Contact with the natural environment can provide an antidote to some of the unhealthy aspects of an urban lifestyle, and there is a growing realisation that this should influence the way that our surroundings are planned and managed. Trees and other vegetation have been used in traditional, modern and alternative medicine as sources of pharmaceuticals and other chemicals. But they also help to moderate the effects of other physical environmental factors by acting as a biological buffer. They can filter potentially harmful air pollution and solar radiation, they provide natural shelter against the wind and they help to cool and moisten the air. Contact with nature and contacts with animals and plants can have a powerful therapeutic or preventative effect on many people, by reducing stress and helping to improve both mental and physical ability. Moreover, access to natural green spaces, particularly if they are conveniently close to work or home, may provide a supportive setting for physical exercise and restorative relaxation. The natural environment also plays a number of secondary roles which can have a positive impact on human health. Vegetation can protect and purify water resources, reduce the risk of storm-water flooding, reclaim contaminated or unstable land, provide local supplies of food and fuel, and help in forging stronger communities.

The following sections present main findings from the six parallel workshop sessions.

Health-related products from natural sources

Plants, including trees, have traditionally been used by conventional and alternative medicine as a source of many different pharmaceuticals, as well as a source of other chemical products. However, there is a great scope for using more advanced techniques in order to identify and extract a greater range of natural products beneficial to health.

Europe's sustainably managed forests and other green areas provide a wide range of products. Trees, besides timber, produce large quantities of wood residues, foliage, twigs, and bark produced during harvesting and manufacturing. Trees have through evolution developed unique chemical defence systems based on advanced functional molecules. Thus trees are exceptionally rich in bioactive, protective substances. Bioactive compounds found in trees include flavonoids, lignans, stilbenes, terpenoids, phytosterols, fatty acids and vitamins which are known to exert many beneficial effects, for example, antioxidant, anticarcinogenic, and estrogenic effects.

Some bioactive compounds can be used as nutraceuticals, that is, a combination of nutrition and pharmaceuticals. These can contribute to

public health as ingredients in dietary supplements and health-promoting ('functional') foods and as pharmaceuticals. In fact, such forest-derived health products have already been developed and marketed at a commercial scale. Xylitol products, for example, promote dental health, while sitosterol products lower cholesterol levels and consequently prevent cardiovascular diseases. Pycnogenol is the trade name for an extract from the bark of the maritime pine growing in France. It is a powerful antioxidant and its impacts on cardiovascular health, skincare, diabetes and inflammations, among others, are studied. In 2006 a new lignan product came on the dietary supplement market. The HMR lignan is extracted from knots (branch 'roots') in spruce trees and can inhibit the development and growth of hormone-related cancer forms (breast, prostate and colon cancers). It is also a strong antioxidant with estrogenic properties. These three products are extracted from process waste streams in the forest industry and are thus contributing to a more efficient use of natural resources.

Although especially forests represent large natural pharmacies by virtue of their enormous source of tree and plant material with known or potential medicinal or nutritional value, more research is still needed to identify and develop the best applications and products. Nutritional supplements and functional foods are currently of high research interest and are recognised internationally as potential health-promoting agents if consumed on a regular basis and at effective levels. The polyphenols which are particularly abundant in knots and bark have potential not only as health-promoting substances but also as technical antioxidants and biocides. There is also potential in using natural, traditionally known extracts from trees as health-promoting products offered locally by enterprises in rural areas. Examples of such products are pine bark as an ingredient in bread and birch sap as a drink or syrup.

Research and related needs

As there is still scant information regarding the bioactive potential of European forest and other natural products/components, there is a need to investigate and discover potential new bioactive components. When searching for potent bioactive compounds in nature, appropriate methodologies should be applied. In general, at first, various plant tissues are subjected to chemical analysis for the identification and determination of individual compounds. In the next step, the plant extract and/or its individual constituents are subjected to many different biotests for the determination of the biological activity and the potential health effects of the plant extracts as a whole or of its components.

To assess the biological activity of plant extracts and plant-derived compounds, an array of in vitro test systems is used. In general, the effect of the tested compounds is examined on various cell lines by using end-point assays, that is, protein or gene expression, which are cell-specific markers reflecting the overall effect of the tested compound on the function of a particular cell system. Cellular assays (proliferation, apoptosis) and mechanistic assays (transfection assays) may also be used. A combination of several in vitro assays is usually required in order to predict the effects in vivo.

However, the in vitro assays do not include metabolites of tested compounds and aspects of the absorption of compounds. Only in vivo studies are able to predict the action of a substance in the organism, since under in vivo conditions the substance is exposed to absorption processes and multiple metabolic transformations. There are various animal models, disease specific, such as tumour models (breast cancer, prostate cancer), the rat model of osteoporosis, and the rabbit model of high cholesterol-induced atheromatosis as well as animal models of brain injury. In conclusion, the use of a suitable panel of different in vitro test systems combined with a final assessment in animal models will predict the real bioactive potential of tested compound(s).

The identification and development of new forest-derived health-promoting products for global or local markets should first of all involve analysis of compounds in different forest tree species and tree tissues – to find new compounds and new sources, as well as basic chemistry of potential compounds. These should be followed by preparative extraction and purification, biotesting in vitro and then in vivo, regulatory approval(s), development of production technology, first on pilot scale and then on production scale, and finally marketing. Patenting and other aspects should also be considered. This endeavour requires interdisciplinary research cooperation between forest scientists, chemists and biomedical scientists, followed by product and business development. Cooperation between scientists carrying out various ways of biotesting is needed in order to identify and evaluate the most significant bioactive substances with respect to promoting human health. Joint research and information exchange by foresters, chemists and biomedical scientists with mainstream clinical pharmacology should develop successful models for scaling up experimental activities to a commercial scale. Support is needed from biomedical and nutraceutical companies to advance through the regulatory systems and finally to the health market.

Human-animal interactions and green care

Humans have been living in association with pets and farm animals for thousands of years. The therapeutic effects of these interactions, however, have only been described more recently. Humans interact with animals in many ways. Interactions such as walking the dog, riding horses or donkeys, contact with farm animals, as well as encounters with animals in the wild have been found to have a positive impact on human health and wellbeing. Impacts can be distinguished and promoted for different groups, such as children and youths, the elderly, stressed and depressed people, and the handicapped. Different approaches within human-animal interaction are recognised. Animal-assisted therapy, for example, involves one or more animals that satisfy certain criteria and are an integral part of the treatment process for a particular client. Animal-assisted activities comprise a less controlled service that may have a therapeutic effect, but which is not true therapy in a strict sense. Venues for interactions vary from the home (for example in the case of pets) and institutions to farms and outdoor environments.

Assessing the variety and extent of interactions between humans and animals presents challenges for scientific research, and it warrants questions such as to what extent research results have transfer values to other human groups, other species, other types of contacts, or other venues. Research to date has demonstrated the health benefits of human-animal interactions for different groups. In the case of children, for example, interactions have been claimed to facilitate stages of development, aid teaching, increase physical activity, and build self-esteem. In the case of youths, interactions with animals constitute a meaningful activity instead of illegal activities and abuse. Adults can benefit in terms of social support for those experiencing life crises, alleviation of loneliness, and improvement of general health. Many of the above benefits also relate to the elderly, while in their case human-animal interactions can also help structure daily life and alleviate isolation.

Most studies to date have looked at pets or companion animals and their effects on human health and wellbeing. Owning a pet, for example, has been shown to be related to a reduction in health problems, a decrease of depression and enhanced chances of survival after discharge from a coronary care unit. The role of animals in a therapeutic setting is recognised as well. In nursing homes, for example, human-animal interactions are associated with a reduction in prescription medication, improved health, reduced mortality, and so forth. There is relatively little strong evidence, however, on positive effects on human health and wellbeing. Even less research has been carried out on the effects of interactions with farm animals. Some findings show that children turn to animals to feel better and that mentally disabled people obtain benefits from living and working on small-scale farm. Therapeutic horse or donkey riding may lead to improved quality of life, higher self-esteem and better social skills. Very few studies have looked into how humans perceive the presence of wild animals when walking in forests, let alone any impacts this may have on people's wellbeing.

Human-animal interactions are one of the important components of green care, also referred to as social farming. Green care deals with the utilisation of farms as a basis for promoting human health, quality of life, and social contacts, in collaboration with health, social and school authorities. It has been given increasing attention in several European countries. Green care involves contact with all the elements on a farm, like plants, animals, colleagues, customers and the landscape. This holistic approach where different interactions are included seems especially beneficial to different client groups. Typically lay persons like the farmer and his/her family are involved in the provision of care, in some cases supported by professionals. Green care comprises an example of innovative collaboration between the agricultural sector and health care sectors. It can play an important role in the ongoing diversification process in European agriculture. The focus in green care is not on therapy, but rather on rehabilitation through working and active participation in a social community on the farm.

Research on green care and positive impacts on human health and wellbeing is still limited so far. Studies do indicate that care farms contribute to the mental, social and physical wellbeing of diverse people in society, such as problem youths, psychiatric patients, mentally disabled and elderly (with

dementia). Care farms can be a good example of providing care in society, outside of health care institutions. The farm offers clients outdoor work that is at the same time both pleasant and useful. Clients have indicated that they acquire more physical and mental strength. The work they do is useful, which gives them more self-confidence and self-respect. The 'green' qualities are important in green care, but evidence also points to the major relevance of interaction of clients with a farmer and a farmer's family, as well as the social effects of working in a community.

Research and related needs

Many needs can be identified for the study of human-animal interactions. Future research must be related to various groups of humans, various animal species, various types of interactions, and various types of venues for such contacts. From the perspective of research design, studies should be based on sound (common) theoretical frameworks. These should look into how animals affect health and wellbeing. Biological, psychological and physiological mechanisms need to be explored. In addition, better research methods and protocols that can be used in different contexts need to be developed. Efficacy studies (of interventions), for example, should involve a variety of designs and address which types of effects are found for which group.

In the case of green care, research should provide farmers and other professionals with a scientific basis for green care services. Sound research should also provide the basis for health policies and economic systems that make it possible for such services to earn a predictable income. Evidence is needed on health promoting qualities of different types of care farms for different types of clients. Green aspects, non-institutional setting characteristics, as well as social aspects deserve consideration. As in the case of human-animal interactions, green care research requires the development of a common theoretical framework and common methodologies. It is very important to include theories and evidence-based practices from health care in the common framework as well, bringing both sectors together and looking at, for example, overlaps and commonalities.

For both human-animal interactions and green care, research will benefit from the creation of scientific networks, for example under the umbrella of COST and the Seventh Framework Programme. An example of a recently established network is 'Farming for Health', which identified an increase throughout Europe in the number of 'care farms' where meaningful manual work replaces further rationalisation of farm activities.

Research networking should go hand in hand with capacity building and enhanced education of professionals and academics on these topics. Practitioners' training has received relatively little attention so far, although practitioners obviously play a key role. They are important for research as well, as they have both tacit and well developed knowledge and hold the key to communicating and demonstrating examples of good practice. Most practitioners' work is a direct resource for public health in the provision of healthy green spaces, especially in urban environments, and in the contribution to greater green space accessibility. Thus practitioners contribute to meeting a number of policy targets. Today nature-based

therapies (green care, horticultural therapy, ecotherapy) are applied all over Europe, although in some countries more frequently than in others. A main problem has been that staff are often recruited as volunteers without any education or experience in health issues. Provision of training is not uniform and integrated into academic levels equitable to those provided for other mainstream practitioners. Further research is needed about what kind of curricula of integrated, vocational or academic training should be developed across Europe.

Therapeutic interactions: plants and landscapes, garden therapy and ecotherapy

As seen, the role of nature, gardens and plants in the improvement of ill health and the maintenance and fortification of good health is not a new phenomenon. Recent studies on these salutogenic effects of the green environment have shown that nature can lower stress levels, restore powers of concentration, and alleviate irritability, while correlations with strengthening of muscles and preventing aches and pain all over the body have also been noted.

Horticultural therapy can be defined as a process by which individuals may improve wellbeing using the garden environment by passive involvement, through stimulation of the senses, or by active involvement, through the practice of horticulture. Taking place in therapeutic gardens, horticultural therapy has its origins in the rehabilitation of British and American soldiers returning from the Second World War. It has a strong focus on healing effects of meaningful activities in the pleasant environment offered by a garden, such as weeding, raking and sowing. This shows its close links with occupational therapy. Distinct values of horticulture to support the healing process include people's physical dependency on plants (related to harvesting crops for food and the like), observing beauty, nurturing of life, and social interaction. There is also growing attention to the key elements of ecotherapy or conservation therapy based on the *active* participation of all those involved in effective conservation or habitat development work, through the *collaborative* efforts of group participants. These meaningful activities carry a social value in terms of the participants' own community integration and in terms of social capital through public green space establishment.

Another challenge is that there is still a need for a sound basis of evidence as to the health effects and mechanisms. Research must involve health outcomes related to therapy settings (for example, a garden or a forest) as compared to results from clinical therapeutic activities. Very few studies so far have reached a standard that can constitute a basis for evidence-based medicine.

Having said this, various relevant theories have been developed. One focus has been on restorative experiences, such as captured in the attention-restoration theory. This theory explains how natural environments can help people renew a depleted capacity for focusing attention. Good restorative environments should enable experiences such as being away, fascination, and compatibility. The aesthetic-affective theory looks at stress reducing

effects of nature as a matter of unconscious processes initiated in the oldest, emotion-driven parts of the brain. The scope of meaning / scope of action theory studies how the surrounding environment communicates with visitor on many levels. Less known and still largely untested theories include that of phytoresonance, which looks at the influence of plant qualities on the human experience and the human reaction to plants. This ranges from passive, merely being outside, to active participation, actively working with plants and soil. Active participation is thought to help develop self esteem, as well as practical, social and emotional skills.

Research and other needs

Most research to date in the field of social and therapeutic horticulture and related fields has been qualitative, and there is a need for more comprehensive and rigorous quantitative research. Although past studies have described and explored the processes involved in the intervention, they have often failed to provide estimates of efficacy or effectiveness. Randomised controlled trials are seen by many in the medical field as the 'golden standard', but such studies are not common in the field of therapeutic interactions with plants and landscapes and they are not always possible to implement. Alternative research designs and methods can at least make use of a standard set of outcome measures. Assessment tools will have to look into wellbeing (for example, self reported), symptoms of illness, and people's functioning. Research should also look at the specific qualities of different types of nature and nature-related activities. Triangulation can offer an alternative as a multi-method, multidisciplinary approach applied in several single settings. Settings are environmental units in which physical features and people's behaviour are indissolubly connected, such as areas in a therapeutic garden specifically designed to support walking, resting and cultivating.

Land use, accessibility to green areas and health effects

Although the general feeling is that nature is good for people's health, nature is not yet widely used for health promotion by public authorities. Green space nearby is often seen as a luxury rather than a necessity, especially in urban areas where the competition for land is intense. Current views on urban densification have led to even greater pressure on remaining open spaces.

Recent studies have looked into accessibility to and use of nature on (self-reported) human health and wellbeing. Studies that compared health indicators with access to green spaces in Denmark, The Netherlands and Sweden, for example, found that both health and wellbeing were better among people who regularly visited nearby nature and green spaces. A short distance to nearby green areas was associated with the number of visits, and subsequently with lower levels of stress. Moreover, people with a garden of their own were found to be less affected by stress.

Although links between green space and health are increasingly well established, little is known about whether nearby nature has an independent causal effect on human health or not. Based on the available evidence such a causal effect is plausible. Suggested mechanisms are, amongst others,

improving air quality, reducing stress, stimulating physical activity, and facilitating social cohesion within neighbourhoods. It is unclear which, if any, of the suggested mechanisms are the most important in terms of generating health benefits. However, it is already obvious that the way to optimise the health effects of local greenery depends strongly on the mechanism that is operative. Using natural elements to catch fine dust will lead to a different optimal green structure than using such elements to create a green oasis to relax and recover.

Past research mainly falls into one of two categories. The first is experimental research, especially on stress reduction and attention restoration. Many of these studies focus on short-term stress reduction, with stress being induced within the experimental setting. Furthermore, usually a crude distinction is made between a natural and a built-up environment, often represented by slides or videos. Based on this line of research it is difficult to say: a) what the (size of) long-term health benefits of exposure to nearby nature in the residential or working environment will be, b) what type of nature will work best, c) how much of this type of nature is needed, and d) whether there are additional requirements that should be fulfilled. With regard to the last aspect, the social safety of green areas comes to mind, especially in an urban setting. The second type of research is correlational in nature (surveys, epidemiological studies). It is better suited to give an impression of the size of long-term effects of nearby nature in a real-life situation. However, the causality of the observed relationships is usually difficult, if not impossible to establish. Furthermore, within this line of research there has been little theoretical development to date. Indicators for the local supply of green spaces tend to vary from study to study, without clear theoretical underpinning. A common quantification method is absent, not only in terms of local supply of greenery, but also regarding health outcomes, making comparisons between studies difficult.

Research needs

As mentioned, more evidence is needed on (the size of) health-promoting and salutogenic effects of different natural outdoor settings in general. Only in this way can 'nature's health service' be properly understood and promoted, for example as part of new strategies for health promotion. The positive links between environment and health will provide a valuable addition to the rather extensive body of evidence of the harmful effects of the environment on human health. Obviously best possible use should be made of data that is already available.

Future research on the health effects of different types of natural outdoor environments should consider many different aspects. From the 'people's side', it should look at different specific symptoms related to (ill) health, such as respiratory problems, stress-related symptoms and obesity. Research and practice need to recognise that variation in socio-demographic aspects, gender, socio-economic aspects and geography may play an important role in assessing and evaluating the role of the natural outdoors. Research should thus consider specific groups within the general population, and focus on questions of how accessibility to various green areas differs and impacts health and wellbeing. Especially visits to nearby nature should be studied as a 'stress-relief' mechanism.

On the other hand, the ‘green side’ of the relation needs further study. For example, do all types of green space work equally well? Is the greenery the main component of the relationship, or perhaps it is rather the peace and quiet often found in nature that affects health? A more functional look at green space is required, asking questions like: what type of green (structure) works how well and for what reason? Characteristics of different types of outdoor environments in terms of noise, pollution levels and other factors also need to be considered. For example, recent study into the composition of outdoor air indicates that volatile compounds in low concentrations can bring about a reduction of tension and mental stress and lead to quick recovery from fatigue.

Linking green space and people, different types of land use in urban and rural areas need to be considered. Mapping of different types of natural outdoor areas, their distance to people, and so forth need to be related to data on people’s health and wellbeing, for example as available from national health surveys. Many cross-cutting issues are at work, such as socio-economic determinants and inequalities in health, gender, for minority groups, and the like. Inequalities often occur in the access of different groups to green spaces, for example in their living and working environment. These inequalities thus could have an impact on health and wellbeing, raising questions of environmental justice with regard to the distribution of and access to public green areas. Accessibility issues are also discussed in the next section on ‘nearby nature’. The quality of the green areas is also likely to be important with regard to promoting human health and wellbeing. High quality spaces (for example, with a good internal and external infrastructure, high aesthetic value, good maintenance, safe) are more likely to be used. A decrease in the level of maintenance may be the start of a dwindling spiral: less attractive, lower level of use, fewer, social benefits, less justification for spending money on maintenance, even lower level of maintenance, and so forth. Finally this may lead to the green space being converted into something else.

A concrete suggestion for future research is to embark on a European-wide effort to map health and green-space data, as a basis for better understanding of the importance of the natural outdoors for human health. Environmental and health agencies are to play a leading role in this effort. It would require a common conceptual framework and methodology. At the national level, existing datasets should be used, such as health survey data (self-reported health and objective measures); census data (details on deprivation and general health); green space/woodland/land use classification data (what areas are available, accessible); and surveys on the use of green space (number and frequency of visits). At the case study level, topics that need to be examined are quality of green space (expert and community views); barriers to access (physical and psychological); exercise and activity behaviour (related to nearby green space); motivations for health and wellbeing (lifestyles, appearance, health); and evaluations of existing projects/schemes (what interventions work and why).

In general, strategic and evaluative frameworks are to be developed to promote the field of nature and health. This should be done within the

context of taking a broader approach to environmental factors (not only on hazards, toxic substances or heat stress). Strategic models such as DPSEEA (Drivers, Pressures, State, Exposure, Effects, Actions) are already in use by organisations like WHO and could assist future research. Evaluative frameworks are needed to evaluate specific projects or interventions on individuals/communities and to assess the impact of quantity and quality of green space at a population level. Core questions to be asked relate to either physical activity or mental wellbeing. Evaluative frameworks need to be longitudinal, interdisciplinary, integrated, and should comprise a combination of qualitative and quantitative methodologies. They should enable the incorporation of baseline data, inclusive of the wider impacts of the project, as well as include output, outcome and process data.

Settlements and localities: health and nature where we live

As mentioned in the previous section, nearby nature plays a very important role in the linkages between outdoor environments and human health and wellbeing. Nearby nature consists of the natural elements and features that people encounter in and around those settings of everyday life in which they spend much of their time, including residential settings, the workplace, and schools. Empirically we can see that people make most use of outdoor spaces that are nearby, in particular if they are close to home, engender a sense of security and ownership, and are attractive. Knowledge of the health benefits of nearby nature can support the design of interventions that serve multiple sustainability goals.

If we wish to deliver public benefit by encouraging activity in nearby natural settings and through contact with animals and greenery then we need to consider how to: compete with people's other interests and calls on their time; motivate and sustain particular behaviours; design and promote appropriate places; identify and target different groups (i.e. segmentation); and fit our activities into the context of wider health objectives.

There is considerable research to show that urban green space is frequently inaccessible. Reasons include physical barriers such as transport corridors, informational barriers where people do not know of areas or of the possibility of using them, disability, ownership issues, particular behavioural problems where the activities of one group exclude others, and barriers related to unattractive or inappropriate layout, location, design and infrastructure. Access requires infrastructure internally and also externally, leading into the area. Green spaces must be attractive to users and have facilities appropriate to the main objective. For example, if we wish to encourage socialising in towns, then small urban parks might be the best option. Differentiation applies both to spaces and activities and to the social groups for whom they are provided. We need research to understand the health benefits of different structures and infrastructures, to establish the scale and scope of benefits (including economics analysis when possible). There is a large body of social research from which it is possible to say that the distinction between rural and urban people is one of location, not of values. Nowadays, people in rural areas are likely to have very similar lifestyles and attitudes to urban dwellers, at least in a European context.

Research on nearby nature and health falls roughly into the following groups: experimental studies of plausible mechanisms; survey studies of anticipated health benefits; quasi-experimental studies of cumulative effects; and cross-sectional epidemiological studies. Some general conclusions can be drawn from this body of research. First of all, non-threatening nature is typically liked. Moreover, people commonly want to have access to nearby opportunities. A brief nature experience can produce benefits that typically have a brief duration, whilst proximity to nature can yield benefits that stand as cumulative effects of repeated brief experiences. However, research is in an early stage and at present faces a number of problems. These include the 'file drawer problem', where results that do not support the hypotheses are filed rather than offered for publication.

Research and other needs

First of all, the lessons learned from existing research can be clarified and should lead to improved future research. Existing bodies of research, such as those concerned with environmental preferences and restorative effects of natural environments, respectively, can be linked to gain leverage on the issue of which environmental configurations might work best to promote desirable effects. Research also needs to chart the processes through which the benefits of repeated, brief nature experiences cumulate (assuming that they do). The role of individual differences needs to be specified and the variation in health outcomes across populations with varying degrees of access described. Research priorities should include further development of measures of the presence of nearby nature for use in understanding the health value of different environmental configurations. Further development of self-report measures to represent mediating psychological processes should also be prioritised. More attention is to be given to prospective studies that estimate associations between engagement with nearby nature and health outcomes, as well as to meta-analytic studies that synthesize the available experimental evidence.

The development of methodologies to measure variables in this field, and establish common cross-disciplinary research language and protocols should be a major aim of research policy in the near future. This should include the development of (economic and other) evaluative systems. It is crucial that future research should be credible within the wider field of existing health-research practice. Because methodologies are still under development it is important that research that shows negative correlations or inconsistencies should be fully reported as an important part of method development. There might also be unintended consequences in poorly considered promoting of natural places. For example parents might move to the countryside believing that their children must have more contact with nature, and as a result face increased commuting and isolation of their children from their social groups. Developing evidence and research methodologies will require cross-disciplinary research and also a combination of quantitative and qualitative approaches. Technologies for spatial organisation of data can make mixed research data readily available. For example, a GIS database can contain a range of data types and thus facilitate cross-disciplinary approaches. GIS approaches are also well suited to research that involves segmentation and might also be an important resource for targeted promotion and communication. Spatial storage and analysis of research data should be a

significant component of future research, including attention to standards and shared platforms.

Special attention in future research should be directed towards groups such as children, the elderly and ethnic minorities, who may have special needs that can be satisfied by nearby nature. Approaches need to be differentiated and tailored to the needs of these and other specific social groups. In the case of children, for example, there are concerns about the impact of a culture of safety and low risk that constrains children's access to outdoor environments, both urban and natural spaces. Across Europe there are considerable differences in the way that children are allowed to access the outdoors, in their 'mobility', and also cultural differences in the way that perceptions of danger and concerns about safety impact on children. A study should be conducted into the mobility of children across Europe, with the intention of identifying positive and negative factors and promoting best practice. This should include urban environments with and without natural elements, and also the possible developmental advantages of access to animals, as well as consideration of school grounds. Cultural diversity of Europe and the probability that immigrant groups are likely to have different perceptions and needs in respect to nature interactions also need study. More data is needed to take account of the needs of ethnic minority groups; this is related to issues of governance and social inclusion that require research.

Planning for health is an increasingly important aspect of urban planning. Spatial analysis and GIS systems, together with remote sensing, are important positive means of analysing and categorising urban green spaces, with a view to planning location, access, infrastructure and the nature of the space. This information base will help identify and promote the various contributions that urban greenery can make to the quality of life in cities, including positive effects on air quality, amelioration of water runoff, reduction of windiness and wind speed, and reduction of temperature through shading and transpiration. High temperatures in urban areas are likely to become increasingly a source of stress, and expansion of green elements can counteract this development. European interest in competitive cities and in the quality of the urban environment as an aspect of competitiveness is an area where green and natural places can make a contribution. One possibility is that sections of society that add disproportionately to the creative life of cities - the 'creative classes' - are likely to be particularly influenced by the presence of high quality green space and nature interactions. A further aspect is the contribution of green spaces to social capital, as places to socialise and also from the sense of shared stewardship of a common resource, especially where communities have participated in the design and implementation of green areas. Another important issue is how to maintain access to nature whilst encouraging densification of urban areas in order to reduce their ecological footprint.

Research shows that visual exposure to nature can be beneficial. Therefore, green design elements such as green roofs and green walls, well-designed indoor greenery, encouragement of wild animals into the vicinity of buildings, and the placement of windows to give views onto green space should be part of urban design. Research on nearby nature should not limit

itself to green spaces, but also look at water, including seascapes as part of the ‘nature infrastructure’.

Health policies and economics

Public policies in many sectors have important health implications. These implications are not always properly assessed and considered. Given the importance of improving health and wellbeing and minimising adverse health effects, it is necessary that consequences are addressed when developing public policy. Gradually, the links between ‘green’ and ‘health’ are gaining more interest from international and national policy-makers. In several European countries, reviews have been carried out or are underway to describe the (research) state-of-art on nature and health, in order to provide a basis for policy. In these reviews, both the direct and indirect influences of nature on health and wellbeing are given attention.

Agriculture and forestry play important roles in linking outdoor environments and health. These roles have changed fundamentally in Europe in the last decades, and the multifunctional character of the agriculture and forestry sectors has become stressed. According to the Organization of Economic and Cooperation Development (OECD), multifunctionality refers to the fact that an economic activity may have multiple outputs, and, by virtue of this way, may contribute to several societal objectives at once. At present, however, mainstream discussions of multifunctionality in agriculture and forestry tend to neglect the health and sometimes also the social values of activities associated with nature. Yet, better opportunities for focusing on services such as those related to human health and wellbeing have emerged, for example due to increasing societal demands, higher awareness about alternative marketable outputs, and the ‘crisis’ of traditional agriculture. European policies in the framework of rural development have encouraged and supported diversification in agricultural enterprises. For example, the health and social services provided by care farms in The Netherlands and other countries are seen as a way to promote diversification and to escape from the impacts of globalisation on agricultural markets resulting in a constant demand for increased farm specialisation. Diversification refers to those situations in which, for example, an agricultural enterprise runs production activities in different economic sectors.

Green care in agriculture can act as a case in point. Presently the organisation of green care activities varies widely across and within different countries. Major differences include the institutional framework in which green care services are provided, which can be public, private for profit, and private not-for-profit. Green care can be arranged in a non-farm situation, in-farm but separated from major farm business, or fully integrated in farm production activities. The latter situation relates to a ‘green care farm’, an agricultural enterprise where the entire organisation takes into account the provision of health and social services. Differences also relate to the target groups to whom such services are addressed, as well as type of ‘benefit’ these receive, such as healing, rehabilitation, social or labour inclusion.

Given the wide range of green care situations, it is understandable that building a framework for analysing economic implications of green care projects and initiatives presents a challenging task. In order for green care to succeed, however, its economic dimensions in terms of costs and revenues need to be understood. Costs for green care include investment cost, such as those related to the adaptation of farm structure to provide green care services. Other expenses are related to management costs such as those for involving care professionals, and transaction costs, that is, all expenses incurred in making an economic exchange. Transaction costs in green care are often high and partly 'hidden', involving costs for research, information and administration. Sound research and information are crucial, as without them the mutually advantageous interaction between the 'green' sectors and health and social sectors cannot be properly developed.

Another issue is how to assess the value of the benefits resulting from green care and other 'green-health' interactions. This requires the development of evaluative systems to quantify the costs and benefits of interventions. Presently public funds are still the main source of direct and indirect payments for green care services. As often in the case where non-market services are provided, payments which are made are mostly related to inputs rather than to outputs.

Research and other needs

The overall ambition of nature-health policies is to help bring about long-term changes in behaviour and lifestyle. This will require a concerted effort to make information available and to offer choices and variety. Communication between all the players - scientists, policy makers and lay people should therefore be a core concern in future research programmes.

Decision-makers need to be supplied with sound evidence that provides further insight into the various effects, positive as well as negative, of nature on health. Most empirical research on positive linkages to date relates to the (short-term) effect on recovery from stress and attention fatigue. However, there has been very limited methodologically sound empirical research into links between nature and (generic) health indicators. More studies on these and other topics should be part of the development of a knowledge infrastructure which should consist of compilation research data and practical examples (good practices), a programme for further knowledge generation, as well as a coordination structure. The roles of the different actors involved should be made clear, for example in terms of responsibilities and financing.

Policy-relevant research needs to address the right questions and look at opportunities and threats. Key questions include, amongst others, what are the health effects of nature in relation to other interventions?, what are the health effects on different target groups?, and what are the costs and benefits involved? Different target groups and their specific needs are to be studied, for example in terms of which types of nature are best for which groups' health and wellbeing.

As mentioned, there is a need for better evaluative frameworks for green care and other nature-health initiatives. Without an overview of the

economic dimensions of these activities, it will be difficult to promote them in a policy setting. Better analysis of the economic dimensions should look at monetary as well as non-monetary aspects, issues of social responsibility, consider impacts on local (agricultural development), and so forth. These assessments will need to be multidisciplinary and look at green care in a wide range of contexts and under varying types of financing. For example, studies of green care farming have mostly looked at care farming activities in isolation. Thus it is difficult to assess their role and meaning within wider farm household strategies as well as possible synergistic effects between different activities.

Summary of research and policy needs

A more persuasive evidence base

Whilst there is a growing recognition of the health benefits of contact with natural surroundings, this is only very slowly being translated into strategies for spatial planning, environmental protection, nature management, education, or into mainstream healthcare policy. Indeed the workshop felt that much current urban planning had a tendency to reduce the opportunities for beneficial access to nature. In the context of development densification, for example, the argument for a comprehensive approach to the provision of a functional urban and rural green infrastructure should be compelling, but at present it is only occasionally applied. The participants of the strategic workshop found this frustrating, but they recognised that a more comprehensive catalogue of research would help in speeding the move towards more evidence-based policy-making. They identified several fields of study which they believe will make a significant difference.

Better use of established data

The established research base is substantial, but widely dispersed. It should be gathered together more effectively, and would have greater impact if cross-referenced against the wealth of other health-care and epidemiological research and statistical data. COST is well placed to share information from across the whole of Europe, to accumulate common evidence and to analyse the gaps in current understanding. One way to help make cross-referencing easier would be to include questions about the *natural* health service in future national health surveys.

Common research frameworks and methodology

In order to make full use of this dispersed evidence base and to aid future academic co-operation there is a need to establish a common theoretical framework which can make it easier to link green-care, health-care and social-care research. This needs to be complemented by development of robust (best evidence base) methodologies which will also make it easier to compare existing but dispersed data. It should also reflect concern for any effect that a more naturalistic contribution to improving public health may have on the plants, animals and the natural environment themselves.

A multifunctional role for green space

The health benefits of access to nature, animals and plants are more likely to be integrated into all aspects of sustainable development if the research community has a better understanding of strategic frameworks, political

priorities, development processes and economic expectations. The health benefits need to be presented as just one of the valuable contributions made by multifunctional green infrastructure, along with others such as the moderating effect on the local impact of climate change, the encouragement of increased economic activity, improved property values, more sustainable options for local travel, and more robust and accessible nature conservation.

Better tools for integration

The mechanisms needed in order to achieve greater integration of the health benefits are themselves an appropriate topic for research, both on a short-term local and a long-term strategic scale. The workshop also identified a particular need to develop economic models which can value quality-of-life outcomes whilst also quantifying direct health impacts. There is a need to demonstrate the costs and benefits of health care which incorporates contact with the natural environment.

Health-related products and commodities from nature

Whilst many of the health benefits which can come from the ‘natural life support system’ might fairly be described as broadly environmental, there is also great scope for deriving beneficial products from natural sources. The workshop discussed the concept of the forest as a living pharmacy, for example. Whilst plants and animals have always been used as a source of pharmaceuticals and other chemical products, there is great scope for using more advanced techniques in order to identify and to extract a greater range of health-related beneficial natural products. The forest, in particular, is a renewable resource and research is already showing that some of those elements which are at present being wasted, such as bark and lignified knotwood, may offer great potential. There is a need to develop and refine analytical and extractive techniques, but there is also a need for joint research with mainstream clinical pharmacology, and for developing successful models for scaling up experimental activity to a larger, and potentially more commercial level.

Therapy and its mainstream application

There is a wealth of experience of the general benefit to public health of living in relatively natural green surroundings, and with having close contact with domesticated animals. There is also the more particular experience of the therapeutic role that personal contact with living plants and animals – both indoors and outdoors – can play in the lives of people with special needs. For example horticultural therapy and the employment of human/animal interaction in psychotherapy are increasingly widely practised. These aspects of health care deserve to be more generally acknowledged, but the workshop also recognised the need for a far better understanding of the processes that are at work here, and closer study of the effect that such interaction may have on the therapeutic plants, animals and the natural environment itself. For example, which types of therapies work best for specific target groups? How does outdoor therapy compare to other types of treatment? Great emphasis was also placed on the value of transferring some of the knowledge and understanding from the specialist therapy units, care farms and other health-based centres of excellence, into the much wider landscapes. With appropriate research, the specialist techniques employed by therapists and others could also be productively

employed in public parks, commercial farms, garden centres, school grounds and institutions such as prisons.

Cross-sectoral 'joined-up' research

As the health benefits of access to nature are increasingly seen in a multifunctional context - as just one of a number of valuable roles which nature can play in people's lives - this will inevitably stimulate the need for a more 'joined-up' approach to (especially applied) research. Joint projects which combine the health benefits of a green infrastructure with such equally important issues as food security and quality, environmental protection and community cohesion need to be explored. The workshop called for a better understanding of the mechanisms required in order to foster this more integrated style of research.

Better communication to influence policy and process

There was a call for more research into effective communication. The workshop identified an urgent need to achieve a better understanding of this more 'natural' approach to healthy living. For those who are involved with the health benefits of contact with nature and with plants and animals it will be important to inform the process of adoption by those who shape other policy areas. This will involve political and policy-making initiatives and it will undoubtedly require a creative approach to working in partnership with others. Most importantly it seems likely to proceed much more rapidly if there is a comprehensive and robust evidence base for the beneficial role played by contact with living plants and animals in the natural environment.

Concluding remarks

There is a convincing but widely dispersed evidence base, confirming the benefits to human health and well-being of close contact with nature, animals and plants. Greater coordination and communication of existing knowledge and understanding, combined with increased investment in new research would help in integrating 'natural health care' into healthy living.

COST has an important role to play in further development of cross-disciplinary research networking, especially between 'green' and 'white' (medical and related) professions. New alliances can be created and key topics for research can be identified, for example for project applications under the European Union's Seventh Framework Programme. This Programme offers various opportunities for future research. Theme 1 of the Cooperation programme provides the most obvious links, as it calls for research to improve the health of European citizens. Mentioned in the programme are, for example, development and validation of new therapies and methods for health promotion and disease prevention. Evidence is to be provided for the best public health measures in terms of lifestyles and interventions at different levels and in different contexts. This includes wider determinants of health and how they interact with, for example, physical activity and environmental factors.

Theme 2 comprises Food, agriculture and biotechnology. It looks, for example, at sustainable production and management of biological resources from land, forest, and aquatic environments. Health benefits could come in

here as part of multifunctional agriculture and forestry. Opportunities are also offered by Themes 6 and 8, respectively on Environment and Socio-economic sciences and the humanities. Under Theme 6, climate change is a major issue, and green areas can help reduce heat stress and other negative effects. Major trends in society and their implications, for example in terms of lifestyle changes, offer openings for nature-health related research under Theme 8.