New Insights

RESEARCH AND KNOWLEDGE
FROM THE SWEDISH UNIVERSITY
OF AGRICULTURAL SCIENCES

2013

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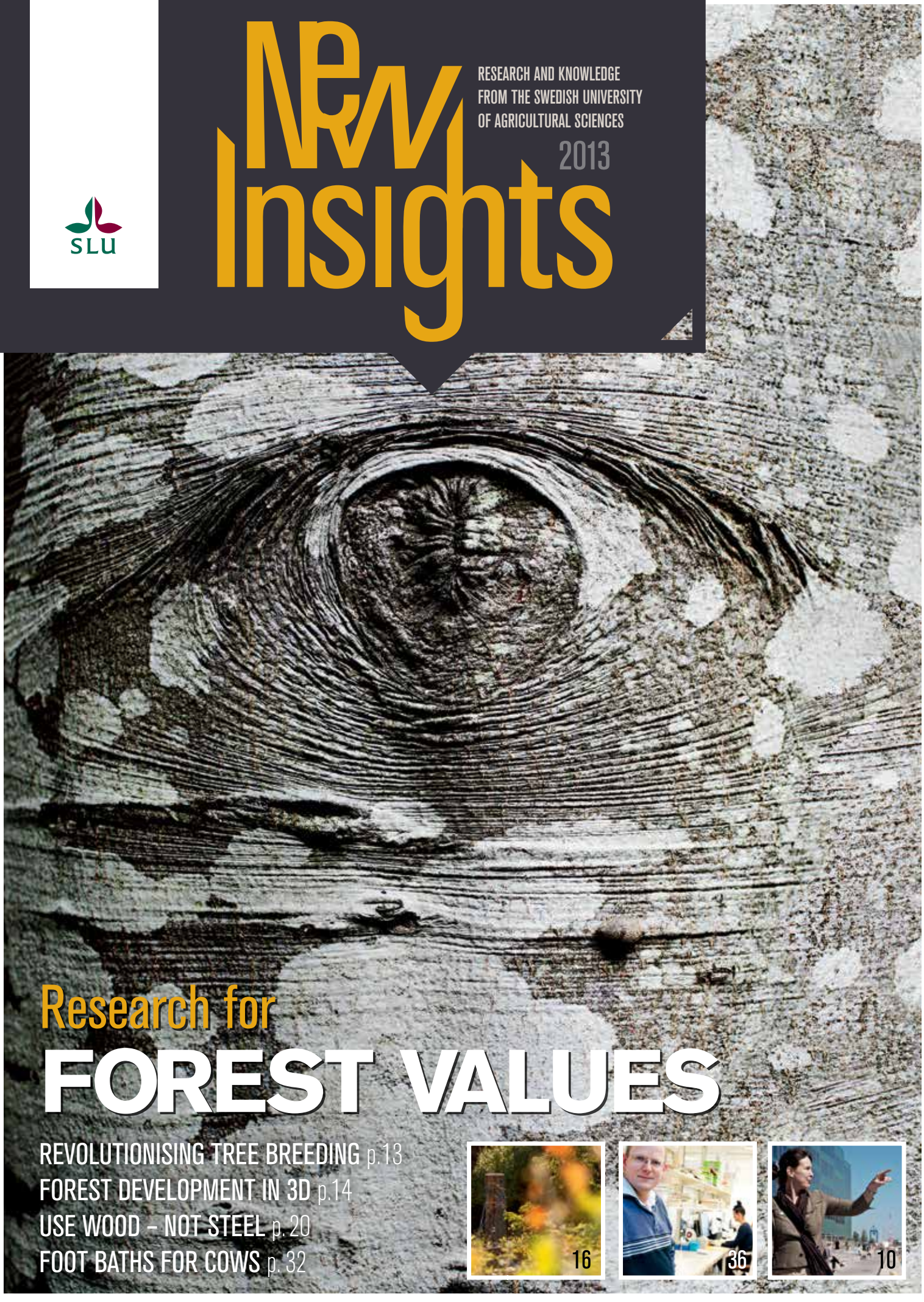

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Sveriges lantbruksuniversitet
Swedish University of Agricultural Sciences

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PHOTO: JENNY SVENNÅS-GILLNER

New Insights

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RESEARCH FOR GLOBAL CHALLENGES

By 2050 there will be over nine billion people on earth. Demands will then grow on the ability of photosynthetic organisms to convert soil, sun, air and water into animal feed, food, fibres and technical materials. The challenge will be to produce more from an existing area without excessive ecological consequences. At the same time, we are seeking to restore and recreate lost natural values, all during an ongoing process of climate change. This task can only be achieved with the help of far-reaching knowledge in the life sciences.

SLU has a profile unique in Sweden, combining pre-eminent research with environmental monitoring and assessment. Our research contributes to resolving global challenges in collaboration with fellow researchers throughout the world, and in close contact with the relevant sectors and the surrounding community, particularly in the fields of soil, forest, water, animals and nature.

Bioscience, systems biology and chemistry are among SLU's priority fields, helping to increase our basic knowledge about plants, animals and micro-organisms. When the genetics behind functions and properties have been mapped, the potential of plants and animals can be better exploited in production. We can also use this knowledge for syntheses and a more problem-oriented approach in fields such as *A bio-based economy* and *Environment, health and quality of life* – for the needs of the global community and in the best interests of the individual.

We hope you enjoy reading this new issue of *New Insights*, a magazine devoted to ongoing research at SLU.

LISA SENNERBY FORSSE VICE-CHANCELLOR, SLU

The return of the wolf

Having been almost completely absent for more than 100 years, the wolf is now rapidly recolonising central Sweden. Its return has met with strong feelings in many quarters.

Wildlife ecologist Håkan Sand is one of Sweden's leading wolf experts, and he is researching under the auspices of *Skandulv – the Scandinavian Wolf Project*. He provides public agencies with data for use in managing the Swedish wolf population.

"The wolf has stirred the emotions of many people. To some, it represents a threat to animal keeping and hunting; others are glad that it has returned to the Swedish countryside. But we do not apply value judgements to wildlife management; we reason strictly on the basis of scientific criteria."

Risk of inbreeding

One issue the researchers are addressing is the risk of inbreeding among the Swedish-Norwegian wolves (*Canis lupus*). The current population is descended from a few individuals that migrated into the region from Finland. Thanks to a unique and almost complete family tree for the wolf population, the researchers can continuously calculate the degree of inbreeding among the wolves.

It is now known that, on average, the wolves are somewhat more inbred than the offspring of full-sibling mating, and it has also been observed that the more inbred the parents are, the fewer cubs there are in each litter.

Predator-naïve moose

Other issues that concern the researchers are wolf mortality and their predation of moose.

"Until 2005 illegal hunting was the main cause of death. This has decreased in recent years, and the most common causes of death among wolves are now legal hunting, road kills and disease."

The predation of moose (*Alces alces*) by wolves is also a controversial topic, since in some areas they compete with human moose hunting. Here, the researchers have been studying how often wolves kill moose.

Radio tagging of wolves provides information about where and how wolves move across the landscape. When tagging wolves, researchers also collect material (tissue, hair and blood) for genetic analyses. Photo: Åke Aronsson

"The hunting success of Swedish wolves is greater than that of their North American cousins, probably because Swedish moose are no longer used to being preyed upon by wolves. We call the moose predator-naïve."

COPY: ULLA AHLGREN

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What makes some horses good trotters?

Horses that are able to rack have a special mutation in their DMRT3 gene, which has an important function in the spinal cord. Professor Leif Andersson, working with Lisa Andersson, who was then a doctoral student at SLU, has found that many Iceland ponies and other breeds of horse with unusual movement patterns have this mutation.

The DMRT3 mutation is also found in good trotting horses, sometimes in double set. This knowledge can be used to make more accurate breeding selection and to better adapt training to the individual horse.

The study has been carried out in jointly with fellow researchers at Uppsala University, and the mechanism is thought to govern the movement patterns of all vertebrates, including humans.

COPY: NORA ADELSKÖLD

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The mutation governing movement patterns in vertebrates is identified. Good trotting horses sometimes have it in double set. Photo: Thomas Blomqvist, Kanal 75

Algae grow well in sewage with the addition of carbon dioxide in flue gases from the power plant. Photo: Francesco Gentili

Growing algae for fuel and feed

Algae grown in sewage and flue gases can be transformed to biogas, bioethanol, biodiesel, fertiliser or fish and animal feed.

Researcher Francesco Gentili has been conducting a unique project in which he has cultivated strains of micro-algae (phytoplankton) in the laboratory. The strains that grew fastest were then tested in a greenhouse prototype cultivation system.

It was found that the algae grew well on a combination of nutrients from untreated sewage and carbon dioxide from a thermo-power plant. The algae absorb carbon dioxide from flue gases and can remove up to 90 per cent of the nitrogen and phosphorus in the sewage. They are also able to fix heavy metals.

The selected micro-algae were found to have a substantially lower ash concentration than marine algae (seaweed), for example, which is important if dried algae are used directly as biofuel. There are also plans to use yeast, which is capable of converting the carbohydrates in the biomass into ethanol.

A sizeable pilot unit with four cultivation basins and a laboratory has recently been built close to the power plant in Umeå. The idea is to encourage the development of algae cultivation, and researchers from several universities and companies are now involved in the project.

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Innovation simplifies surgery

To prevent bleeding during and after castration of dogs, the normal procedure is to tie a suture around the blood vessel. Earlier research showed that traditional nylon cable ties made the operations quicker and simpler, but the material caused tissue reactions in dogs.

Researcher Odd Höglund has now developed a medical innovation, a surgical tie that is resorbed into the body. The design is adapted for surgery; it is self-locking and bendable and can be fitted with one hand. This allows for quicker, easier and safer surgery, which may also shorten the recovery time for patients.

The first studies used cable ties made of injection moulded polydioxanone, the same material as that used for sutures. A more manageable mixture of various resorbable polymers is now being evaluated, and clinical trials using the new product in dog castration procedures, among other things, are in progress.

The product (LigaTie) has been patented and Odd has started a biotech company called Vetok AB, in collaboration with *Uppsala Innovation Centre*. Commercialisation, new studies and development of similar products for human use are next on the agenda.

COPY: NORA ADELSKÖLD

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The resorbable cable tie has been developed at SLU to make operations safer and more straightforward (above). Photo: Jenny Svennås-Gillner.

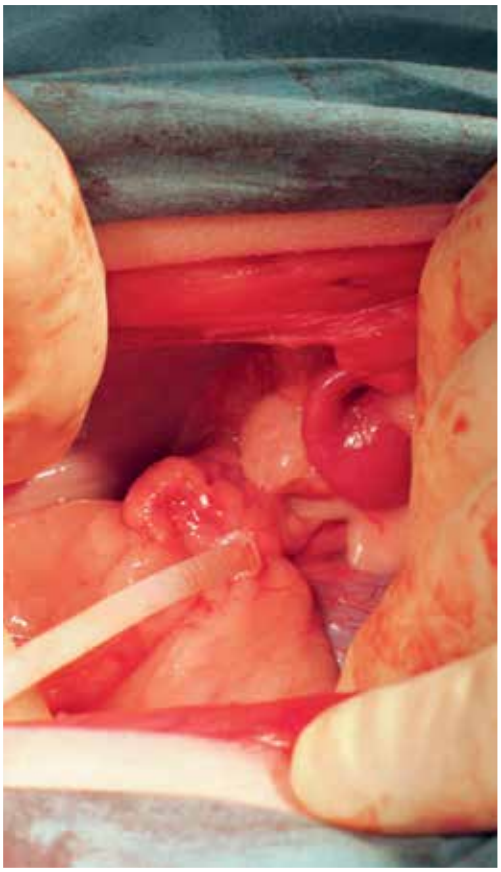

Photo of the device used during removal of ovaries in a dog (to the right). Photo: Odd Höglund

URBAN DEVELOPMENT

PLANNING FOR CHILDREN, AND FOR GLOBAL CHALLENGES.

Cities must be designed so they offer ample opportunity for children to play.
Photo: iStockphoto

PHOTO: GUNNAR CERWÉN, SLU

The researcher

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"…One way of increasing children's desire and ability to move around in their daily lives is to consider how we design and structure outdoor urban environments."

Planning cities for playfulness

Increasing numbers of the world's children grow up in cities. Outdoor urban environments are therefore of growing importance for children's day-to-day mobility.

IN SWEDISH
Allt fler av världens barn växer upp i städer. Därför får också städernas utemiljöer en större betydelse för barns rörlighet.

www.slu.se/kunskapsbank/stad-landskapsarkitektur

"Swedish children are less and less active, something we must try to change. One way of increasing children's desire and ability to move around in their daily lives is to consider how we design and structure outdoor urban environments. The current trend is for greater building density in urban areas. Unfortunately, this makes things more difficult for children," says SLU researcher Maria Kylin.

How, then, to create an urban environment inviting play and movement, which benefits children's health in both the near and the long term? It is recommended that ten-year-old girls should take at least 12,000 steps a day, and boys 15,000.

Safe and attractive playgrounds

Maria is researching into ways of planning and designing cities from the perspective of young people. Among other things, she has concluded that children prefer play areas with flower beds, shrubberies and good play equipment. She has also found that play areas sited close to well-frequented paths and cycleways are felt to be safe and are therefore used more often than those that are out of the way.

One aim of Maria's research is to develop analytical methods that can be used by local and regional authorities when planning urban environments.

Children's wishes recorded

"Planning is needed at different levels, from the overall structure of the city, e.g. green structures and cycleways, to small-scale environments such as play areas and schoolyards. The method is based on children's view of the urban environment. We examine where children most want to play and spend time during the day."

The results are then combined with the criteria used by planners and architects when they draw up urban planning proposals.

COPY: ULLA AHLGREN

IN SWEDISH

Flera svenska kommuner använder metoden *Barnkartor i GIS* för att ta reda på hur barn upplever sin utemiljö. Metoden bygger på en dataenkät, där barnen svarar på sju frågor om sina favoritplatser i staden eller förorten.

www.slu.se/kunskapsbank/stad-landskapsarkitektur

Putting children on the map

A number of Swedish municipalities are using a method called "Children's maps in GIS" to find out how children feel about and use their outdoor environment.

"Under the UN Children's Convention, children have the right to be involved and have a say on issues that affect them. Societal planning of outdoor environments for children is a case where children's voices should be heard," says researcher Ulla Berglund, who has developed *Children's maps in GIS* (*Barnkartor i GIS*) together with her colleague Kerstin Nordin. The project is part of SLU's environmental monitoring and assessment.

Children's maps in GIS helps local authorities to incorporate children's perspectives in the planning of e.g. roads, schoolyards and increased urban building density.

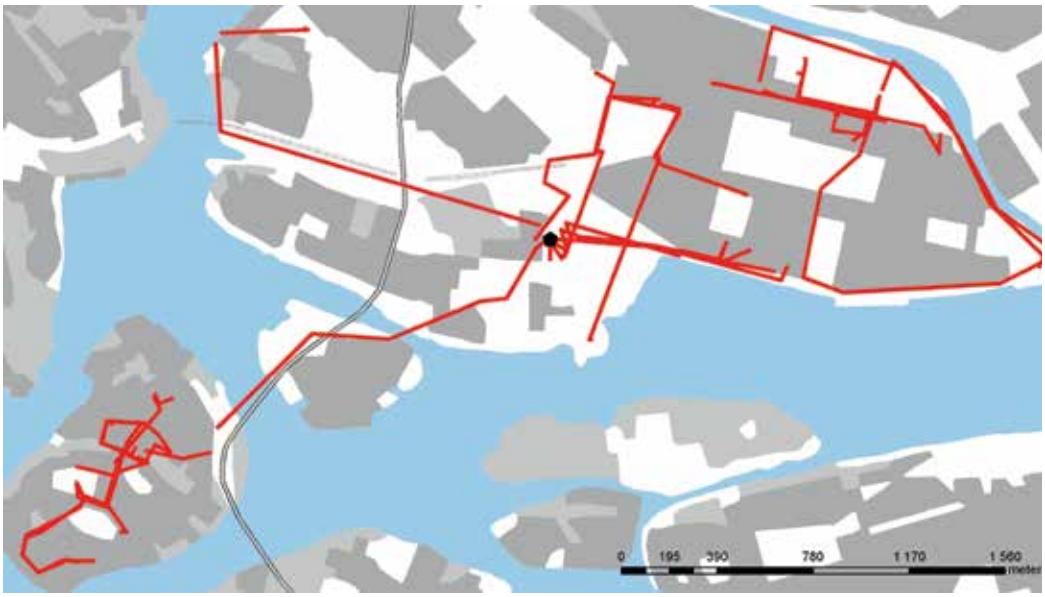
The method is based on a data questionnaire, in which children answer seven questions about the way they use and feel about their outdoor environment. They answer by marking places and roads on a digital map.

Among other things, the researchers have used the method for a district in central Stockholm and in a suburb of the city. There, fifth-grade schoolchildren were asked to draw and describe how they perceived their outdoor environment.

Can walk on their own

"Children in the suburb had many favourite spots, and they were able to get to their friends and activities on their own. The maps show that their routes used in their leisure time were spread out," explains Kerstin.

In the city-centre district, however, the children's routes were fewer.



Not being afraid to walk or cycle to school or to friends' houses and activities is a step towards becoming an independent individual. Photo: Ulla Berglund, SLU

Children's maps in GIS: Kungsholmen, close to Stockholm city centre (upper map) and Bredäng, a suburb of Stockholm (to the left). The black dot is the children's school, the red lines are their routes. Children in Bredäng had more favourite places, whereas Kungsholmen children did not have knowledge about that many places.

PHOTO: MALENA NILSVED

PHOTO: MALENA NILSVED

The researchers

Kerstin Nordin, landscape architect and researcher at the Department of Urban and Rural Development, SLU, Uppsala.

Ulla Berglund, landscape architect and researcher at the Department of Urban and Rural Development, SLU, Uppsala. PhD, Royal Institute of Technology (KTH), 1996.

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"Here, children have a very long way to get where they want to go. For adults, the distances are short, but not for children," Ulla adds. "The children's answers also showed that they spent much of their time at home; they said things like 'I don't go out much'. Children do not have the same opportunity as adults to choose where they go. They are confined to their local environment around their home and school to a greater extent".

Realistic and practical wishes

To a large degree, *Children's maps in GIS* focuses on traffic issues, since the route a child takes to school is an important factor in local planning. But the researchers would also like to know what children do outdoors in their spare time.

"*Children's maps in GIS* involves both the brain and the heart. 'Do you have a favourite spot out of doors?' is one of the questions we ask," Kerstin explains.

Children can also suggest changes. They have often been found to be very specific and realistic in their wishes.

"They might suggest that lights, football nets and park benches be mended, and that ugly graffiti be removed. Since children and young people are the ones who make most use of the local environment, it is important that they perceive it to be attractive and safe, so that they want to spend time there," says Ulla. ■

COPY: ULLA AHLGREN

Professor Lisa Diedrich at Malmö's transforming harbour. Photo: Kolbjörn Guwallius

Hybrid knowledge needed for urban adaption

The researcher

Lisa Diedrich, Professor of Landscape Architecture at the Department of Landscape Architecture, Planning and Management, SLU, Alnarp.

Has studied architecture and urbanism in Paris, Marseille and Stuttgart, specialising in contemporary European landscape architecture. Has worked in Germany, France, the Netherlands, Spain, Italy, Denmark and Australia.

Editor-in-chief of the book series *Landscape Architecture Europe* and of *'scape – the international magazine for landscape architecture and urbanism.*

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RESEARCHER'S COLUMN *by Professor Lisa Diedrich*

Cities must change along with global challenges such as demographic changes and climate change. Landscape architecture has the broad knowledge of living environments that a sustainable urban development requires.

In these early years of the 21st century, western Europeans, accustomed to the comforts of the welfare state, are experiencing great turmoil: unstable economies, demographic decline, shrinking resources, changing climate. Most live in cities, or better: in metropolitan areas, made up of a patchwork of houses, factories, roads, railways, fields, forests and water bodies.

These urban areas face major changes in their transition to a sustainable way of life. Some researchers speak of three urban revolutions: the creation of cities in the first place, the development of the industrial city, and the shift to the European city of the globalised world.

New theories

Today, the inherited urban planning methods fail, as they are based on old modernistic principles such as growth and extension. Here, as I have learned on my professional journey across Europe and Australia, landscape architecture can help to improve our understanding of, and approach to, urban areas.

As an academic discipline and professional field, landscape architecture represents a solid body of theoretical and practical knowledge about living environments. It treats natural spatial conditions and nature processes on an equal footing with man-made elements and human practices.

This means that things that "work" together are studied and shaped together: a city in a flood-threatened delta, recreation areas on old docklands sites with a cultural heritage, or a higher-density housing district for a multi-ethnic community on a wind-exposed ridge overlooking a protected wood.

"Thinking eyes"

Landscape architecture relies on the assumption that things do not exist in isolation from one another, but are moving parts in a complex network of simultaneous, multidirectional exchanges.

As a design discipline, landscape architecture observes and describes the existing spot, often through maps, while also transforming and shaping it. This involves knowledge from the natural and social sciences as well as from the arts, rationality as well as the senses; landscape architects have "thinking eyes".

At SLU, I see a great opportunity to develop education and research for, on and through design. We must generate the hybrid knowledge we need to adapt the urban environments to the conditions of this century. ■

Examples of urban transformations in Europe involving landscape architects

Plateau de Haye residential district in Nancy. Photo: Lisa Diedrich

Tagus Bike Track on Lisbon's port wastelands in front of the historic town. Photo: Lisa Diedrich

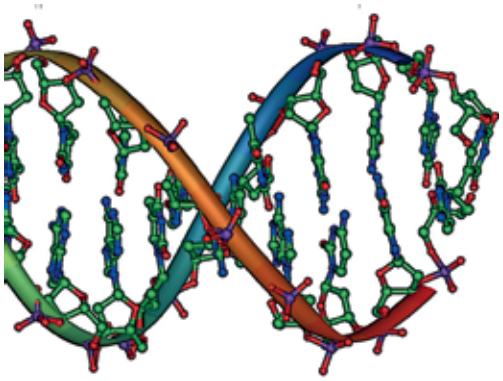
Rotterdam's Kop van Zuid in the Rhine-Meuse delta, an example of a flood-threatened city. Photo: Lisa Diedrich

FORESTRY

PLANNING FOR MARKET, BIODIVERSITY AND RECREATION.
SPRUCE GENOME, WOOD CELLS AND GREENHOUSE GASES.

Spruce growing in a phytotron, a plant cultivation unit in which the climate and light conditions can be controlled. Photo: Julio Gonzalez

PHOTO: MATTIAS PETTERSSON



The spruce DNA is made up by 20 billion 'building bricks', the nucleotides A, C, G and T. Illustration: Wikimedia commons

The researcher

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Revolutionising spruce breeding

Researchers will soon have cracked the genetic code of Norway spruce, benefiting tree breeding for better plant material in the process.

IN SWEDISH
Snart har svenska forskare knäckt granens genetiska kod. All denna information ska sedan samlas i en databas, som förhoppningsvis kan komma att revolutionera förädlingen av barrträd.

www.slu.se/kunskapsbank/skogsbruk

The *Spruce genome project* is a major project on spruce genes at *Umeå Plant Science Center* (UPSC). This spearhead genetic engineering project is now in the process of mapping, for the first time, the germ plasm of a conifer tree. Norway spruce (*Picea abies*) is the most important tree in Sweden, economically and ecologically.

The first version of spruce DNA was sequenced using effective gene sequencing devices at the *Science for Life Laboratory* in Stockholm.

"Preliminary data suggest that Norway spruce, although it has a genome that is more than ten times larger than most plants, does not have a greater number of genes. The remainder of the germ plasm consists of innumerable rows of repetitive DNA sequences whose function is unknown," explains Professor Ove Nilsson, who is leading the steering group for the project, in which Swedish researchers are working with fellow scientists from Italy, Canada and Belgium.

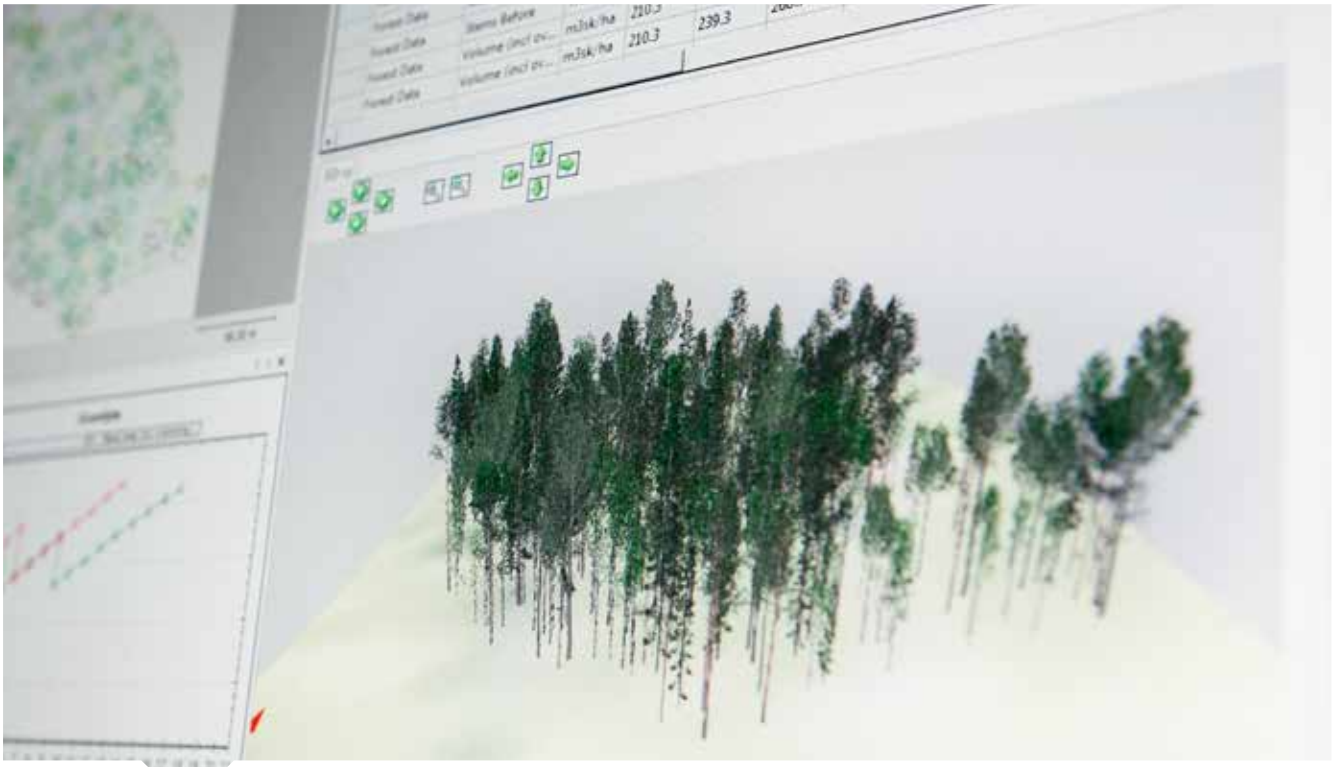
But identifying the genetic code of spruce is only a small part of their work. They also have to place the 20 billion 'building bricks' (the nucleotides A, C, G and T), that make up the germ plasm, in the right order.

Markers for good growth

At the same time the team is using the mapped genome sequence to develop methods of finding genetic markers for various desirable spruce characteristics. These may be more vigorous growth, resistance to diseases and pests, drought tolerance and specific wood characteristics.

"All this information will then be collated in a database. Hopefully it will revolutionise all research and breeding of coniferous trees, and help the forestry sector to develop better plant material that is hardy and healthy and adapted to both poor and fertile soils in a variety of climates."

COPY: NORA ADELSKÖLD



The StandWise interactive simulator in Heureka can be used to study a stand of trees in computer-generated 3D. Analyses can be made of near and long-term forest development in terms of timber and biofuel production, financial return, etc. Photo: Jenny Svennås-Gillner

Heureka – balancing forest objectives

Swedish forest owners can now use their computers to see how their management actions affect forest areas. A single tool can be used to combine economics, ecology and social values – a globally unique concept.

The tool is called *Heureka* and is a forest analysis and planning system developed by SLU researchers.

"How can forests close to urban areas be made more suitable for recreation and how much forest will be available for moose grazing in the future? These are the kind of questions that the Heureka system can answer," says Tomas Lämås, who is heading the *Forest Sustainability Analyses* programme.

Tool for better decisions

The unique feature of Heureka is that it enables users to compare the long-term consequences of various types of forest use. The software can be used to generate maps and diagrams showing, for example, the implications of a change to more intensive forestry for timber production and biodiversity.

"It is fairly easy when standing in the forest to assess whether an individual stand of trees needs to be thinned. But the help of a computer will be needed to plan the management of large areas with many stands and differing management objectives," says Karin Öhman, one of the team developing the Heureka system.

Planning may also be even more complex if more stakeholders than the forest owner are interested in the future of an area, e.g. outdoor pursuit associations and municipalities. Issues may then arise concerning the scope for recreation, mushroom gathering and forage for wildlife species. In these situations Heureka's multi-objective analyses can provide useful support and make planning more transparent.

"Stakeholders can value the economic, ecological and social aspects. The result weighs up conflicting objectives on the basis of objective facts and subjective preferences," explains Karin.

Cutting edge

The Heureka system is at the forefront of international developments in this field, with its multi-objective analyses and ability to analyse various forest values on different geographical scales. The SLU researchers are also contributing their expertise in the EU, e.g. via *Forsys*, *Integral* and *Arange*.

What happens to biodiversity, grazing for wild animals and recreational values after forest has been felled? This can be visualised using the Heureka planning tool developed at SLU. Photo: Skogenbild

Many major forest owners in Sweden already use the Heureka system in their long-term forest planning. Tomas has already seen that Heureka has made its mark on the forest landscape, e.g. by increasing voluntary designation of set aside areas as a result of landscape analyses. However, the researchers also believe that small and especially owners of medium-sized forests can benefit from using the system.

International interest

The researchers have also noted great interest from other countries, most recently from neighbouring Norway.

"Norwegian forests are good candidates for Heureka, since the climate is similar to ours and the tree species are the same," explains Tomas.

This is important because the basis for the program is the way Swedish tree species grow at Swedish latitudes. But it is quite possible to use Heureka in other parts of the world as well, although the tree models used by the system must then be adapted to local conditions and tree species.

COPY: ULLA AHLGREN

Researchers Tomas Lämås and Karin Öhman are involved in developing the Heureka planning tool. They have taken part in various landscape analyses, e.g. evaluating the long-term effects of continuous forestry on the landscape of a Swedish municipality. Photo: Mona Bonta Bergman

IN SWEDISH

Svenska skogsägare kan i sin dator se hur olika skötselåtgärder påverkar små och stora skogsområden på kort och lång sikt. I ett och samma hjälpmedel kopplas ekonomi, ekologi och sociala värden ihop – ett världsunikt koncept.

www.slu.se/kunskapsbank/skogsbruk-vilt

The researchers

Tomas Lämås, leader of the Forest Sustainability Analyses programme at the Department of Forest Resource Management, SLU, Umeå. PhD, SLU, 1996.

Karin Öhman, assistant leader of the programme, SLU, Umeå. PhD, SLU, 2001.

Both researchers take part in the EU projects Arange and Integral, and also in the EU collaboration Forsys (Forest Management Decision Support Systems).

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Restoring forests little by little

New research has shown that high stumps left during clear cutting greatly favour biodiversity. Some rare insect species can breed on the sun-exposed stumps. Photo: Nic Kruys/N

"Caring for the environment is a way of restoring our forests while we use them," explains Lena Gustafsson, Professor of Nature Conservation Biology.

Clear cutting continues to predominate in the boreal forests of the world. This has an enormous impact on biodiversity. But a new approach in forestry, known as *retention forestry*, is beginning to spread across the world.

Retention forestry involves retaining key forest structures when felling, e.g. small stands of broadleaf trees, old trees and dead wood. Nature conservation becomes an integral part of forestry.

"This enables a number of rare species of lichens and insects, for example, to survive and live in the growing new forest. The landscape is also more varied – more of a patchwork," says Professor Gustafsson.

Concern for nature at every stage

She is leading an interdisciplinary research programme, called *Smart hänsyn*, which reflects various aspects of concern for the environment.

Using the Heureka forest management and planning model, researchers can describe the number of old trees and the amount of dead wood, as well as future timber production based on felling scenarios with different levels of environmental concern. It will also be possible to visualise these changes in the form of two-dimensional computer-generated images.

PHOTO: LARS KLINGSTRÖM

The researcher

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Smart Hänsyn also encompasses the social sciences. For instance, a political scientist at Umeå University is studying the factors that ultimately lead to effective environmental concern in the forest. What are the weak links in the chain from laws and certification requirements, via public agencies and forest companies, to the machine operator?

Wide variation between countries

Professor Gustafsson recently coordinated an international comparison of environmental concern in forestry in eleven countries (see map on next page).

"We found wide variation between the countries in the proportion of forest retained during felling, from 3 – 5 per cent in the Nordic region to 20 – 30 per cent in British Columbia and Tasmania. In many places a broad swathe of forest is also retained along watercourses, sometimes up to 100 metres wide, in the interests of water quality, fisheries and outdoor recreation."

The low retention levels in Sweden and elsewhere are the result of a long history of forestry, with many private forest owners. It is easier to enforce higher retention levels in countries with a high proportion of state-owned forest and forests that have never been felled.

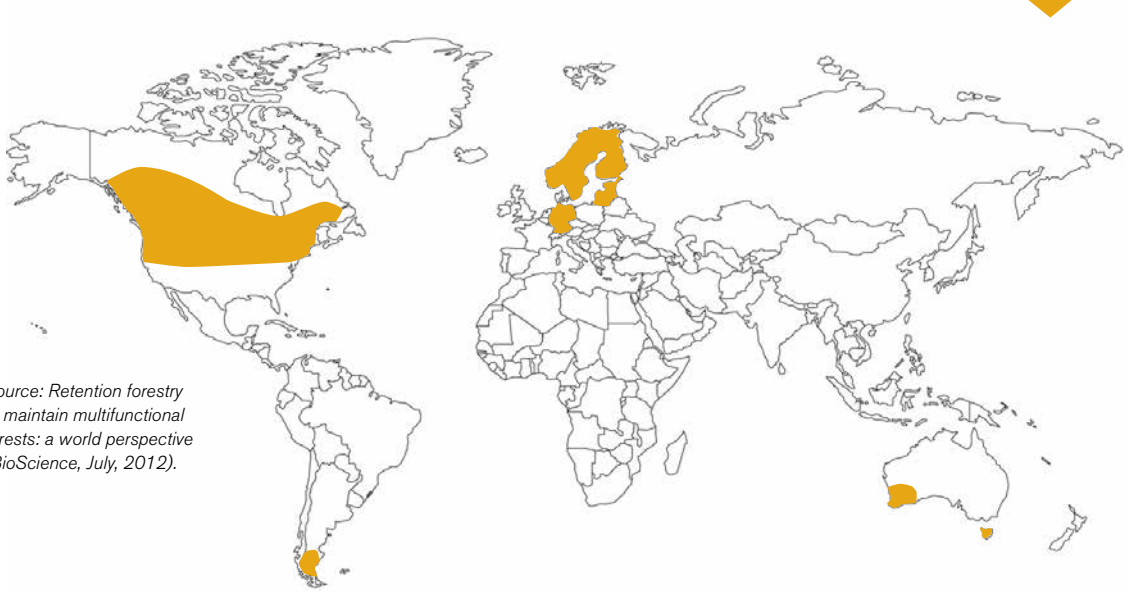
Better effect with local adaptation

The requirements governing environmental concern in the law and in certification regulations are the same for the whole of Sweden.

"We would get more back for the money that environmental concern costs if it were differentiated, with greater local and regional adaptation."

For instance, Professor Gustafsson thinks that it is a

Areas of the world where retention forestry is being practised.



Source: Retention forestry to maintain multifunctional forests: a world perspective (BioScience, July, 2012).

A patchwork of areas with trees of different ages typifies retention forestry in Sweden. Tree zones around clear cut areas are spared, along with dead wood and old trees which provide living space for many species, even though the areas around them have been cut.
Photo: Nic Kruys/N

Dead wood is essential to a wide range of forest-dwelling species.
Photo: Nic Kruys/N

A swathe of trees is retained along the watercourse. They provide shade, which is important for water quality and water organisms. There is enough light for new bushes and broadleaf trees to establish.
Photo: Nic Kruys/N

good idea to take nature conservation measures close to key biotopes and other areas rich in biodiversity. This enables species in those forest areas to spread to the older trees retained in the regenerating forest.

Same principle in the tropics

"Retention forestry is also suitable in temperate, subtropical and tropical forestry," says Professor Gustafsson. "The principle is the same – saving whatever is important for the biodiversity existing at the location in question."

Fires are uncommon in tropical regions, and virgin forest often covers large unbroken areas, where selective felling should be practised so that their ecosystems can continue to function. Here, certification is an effective driver of more environmentally friendly forestry.

"I hope that environmental concern continues to grow throughout the world, and that a greater proportion of old trees are spared. And they must be left standing for generation after generation so that there will ultimately be a broad span of ages in tree stands – an entirely different kind of forest from the ones we see today."

COPY: NORA ADELSKÖLD

IN SWEDISH

Ett nytt synsätt inom skogsbruket börjar sprida sig över världen. Naturhänsyn är ett sätt att restaurera skogarna medan vi brukar dem.

www-slu.se/kunskapsbank/skogsbruk-vilt

Wood is good for the climate

IN SWEDISH
En ökad skogstillväxt innebär att skogen tar upp mer koldioxid, som därmed lagras in snabbare. När man använder mer träråvara ökar skogens klimateffekt ytterligare.

www.slu.se/kunskapsbank/skogsbruk-vilt

Rising forest growth rates mean that forests absorb more carbon dioxide, which is then stored more rapidly. Using more products made of wood can further enhance the contribution made by forests to climate mitigation.

Unless timber is felled in the forests and used in wooden houses and other constructions, forest growth will slow, and forests will in the end emit as much carbon dioxide as they absorb. Photo: Träguiden

Researcher Johan Bergh is studying how future climate change may affect forest growth in northern ecosystems.

"We face progressive climate change, which will alter the conditions for forest growth," he says.

A changing climate will also impact other forest organisms, e.g. the species composition of ground vegetation, pests and other forest fauna. But Johan points out that the opposite also applies. The forest impacts climate in that carbon dioxide is absorbed by trees, thus slowing the rate at which this gas is increasing in the atmosphere.

Timber products add benefit

In a heavily forested country like Sweden, where more than 60 per cent of the land mass is covered with forest, changes in forestry strategies involving greater and different use of timber products can be of considerable added benefit to the climate.

"From a societal and climate viewpoint, steps should therefore be taken to fix more carbon dioxide and at a faster pace in growing forest and, more than at present, replace fossil fuels and energy-intensive materials such as concrete and steel, with carbon dioxide-neutral timber products.

The higher rate of forest growth in a warmer climate is thus a good thing in both the near and the long term.

The end of the road

But if the short-term option is chosen, i.e. allowing forests merely to store carbon without felling them, a point will most likely be reached where they cannot store more carbon and will emit as much as they absorb.

"Eventually we will reach the end of the road, so it is better in the long run to use more wood as a substitute for concrete and metal constructions, and particularly for fossil fuels.

Johan has been one of SLU's extension specialists since 2012, and is very much in demand as a speaker.

"Cooperation between the research community, society and the forest sector is absolutely critical from a climate perspective. This will require a dialogue, in which SLU will play a key role."

COPY: OLOF BERGVALL

The researcher

Johan Bergh, Researcher at the Department of Southern Swedish Forest Research Centre, SLU, Alnarp. PhD, SLU, 1997.

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Mapping the ultrastructure of wood

The structure of wood cells determines how strong and moisture-resistant the wood is, and also how easily it is attacked by various wood-degrading fungi. New knowledge about wood fibres is of benefit to the timber, pulp and paper industries, as well as to house and ship builders.

Wood cells have two walls. The structure of the inner wall has not yet been fully researched. The ultrastructure of this secondary wall greatly influences the mechanical characteristics of a wood cell. It contains a heterogeneous mixture of cellulose, hemicellulose, lignin, pectin and protein, which together form strong biopolymers.

Basic and applied research is being conducted at SLU across a broad spectrum, from the ultrastructure of wood fibres and the anatomy of wood, to degradation processes and wood protection.

Professor Geoffrey Daniel is attempting to map the secondary cell walls, and is heading a project on paper pulp as part of *Cooperative Research on Ultrastructure of Wood Fibres* (CRUW). In partnership with pulp and paper companies, work done by researchers includes improving the energy efficiency of chemical and mechanical pulp manufacture using various forms of pre-treatment, while also maintaining paper quality. ■

COPY: NORA ADELSKÖLD

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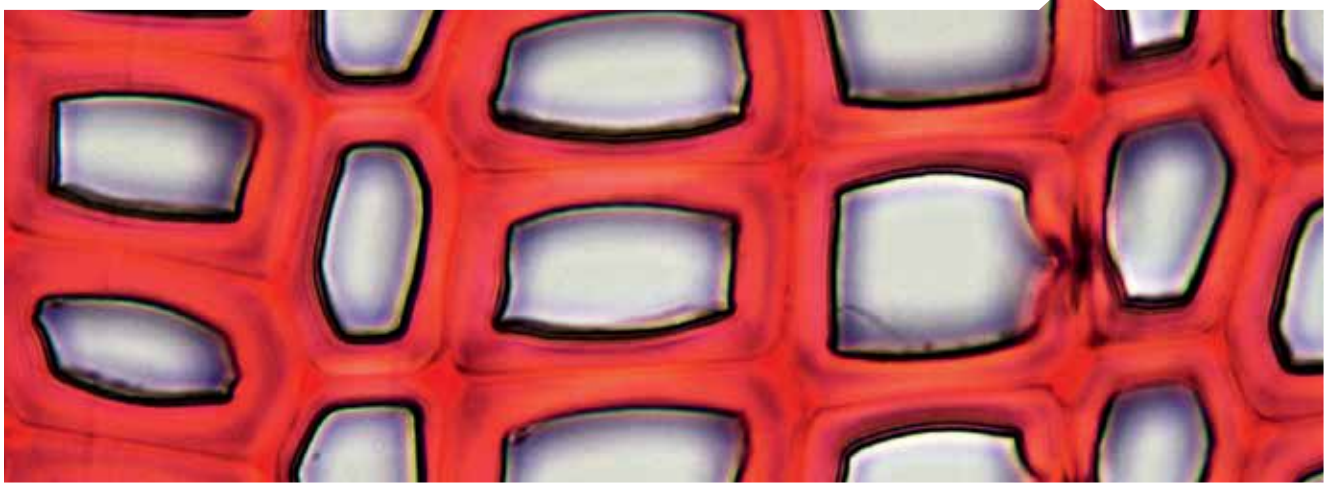
The characteristics of wood depend on the highly detailed structure of the wood cells. Tainted spruce wood fibres seen under a light microscope. Photo: CRUW



Forests at centre of global tug of war

Forestry is impacted by many trends, e.g. climate change, rising demand for wood and bioenergy, as well as rapid demographic and economic growth in some regions of the world. The ability of trees to fix carbon dioxide may come to play a central role in climate and forest policy. Competition between food and fibre production, e.g. in Brazil, may also end up impacting the profitability of Swedish forestry.

Researcher Karin Beland Lindahl thinks international trends will increasingly influence the way forests are used. She is working on *Global trends*, a sub-project under the SLU *Future Forests* interdisciplinary programme.

Demands on our forests will continue to increase, bringing growing competition for land and raw materials. Conflicts are more likely to increase than abate. Climate and energy policy will embrace forest issues in earnest, and the boundaries between the forest, energy and agricultural sectors will probably become less distinct. Conservation of biodiversity, energy needs and climate threats may be pitted against each other in discussions of how the world's forests should be used. ■

COPY: NORA ADELSKÖLD

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The profitability of Swedish forestry is influenced by many things, e.g. the competition between food and fibre production in Brazil. Photo: Nora Adelsköld

Woodland fringes by a lake are one type of rehabilitative spots. Photo: Ann Dolling

Soothing forests cure burn-out patients

Open pine woods and heaths and woodland fringes have a soothing effect, and can help people to recover from stress-related conditions.

Mental health problems have increased in Sweden despite rising living standards. These problems manifest themselves particularly in the form of stress-related problems and various fatigue conditions.

Over the past two years researchers Ann Dolling and Ylva Lundell at SLU in Umeå have been conducting a research project entitled *Forest and health*.

"Right from the outset we have had broad and close collaboration within SLU and also with other universities, particularly with medical researchers at Umeå University," says Ylva.

The forest has been found to be an undemanding environment well-suited to rehabilitation. There has been a sub-project studying the types of forest and woodland environments that are best suited for rehabilitation.

Medical tests

Patients were provided with GPS transmitters to allow continuous monitoring of their choice of recreational environments. This was followed by medical tests and interviews to identify any perceived improvement.

"Open pine woods and heaths were found to be good environments, and spending time in woodland fringes or by a lake engendered a feeling of calm," says Ann. "We have also seen from the studies that the subjects experience a positive change after spending only a few hours in a forest environment. They feel they have more energy and are more harmonious."

Searching for rehabilitative spots

In a planned forthcoming sub-project Ann and Ylva, along with colleagues at SLU in Alnarp, will be identifying woodland areas offering potential as rehabilitative environments, and studying their distribution in the landscape.

"We will then be able to use the Heureka planning and management tool to make scenario analyses of how the percentage of rehabilitative woodland required can be combined with forestry with the minimum possible economic loss," says Ann.

COPY: OLOF BERGVALL

IN SWEDISH

Skog har visat sig vara en kravlös miljö som är bra för återhämtning för människor med stressrelaterade besvär. Öppna tall- och hedmarker eller skogsbryn har en lugnande effekt.

www.slu.se/kunskapsbank/skogsbruk-vilt

PHOTO: ULF RENBERG

PHOTO: SARA KARLSSON

The researchers

Ylva Lundell and Ann Dolling, researchers at the Department of Forest Ecology and Management, SLU, Umeå.

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Getting a grip on greenhouse gases

The exchange of greenhouse gases between the earth's surface in Europe and the atmosphere has hitherto been monitored in separate projects, but a European network of monitoring stations is starting to take shape.

"We need reliable data on which to base decisions and action to reduce climate change," says Professor Mats B. Nilsson, who is a member of the Swedish team.

His research focuses on carbon cycles and particularly the role played by wetlands in relation to greenhouse gases in the atmosphere.

The technique used to continually monitor greenhouse gas exchange has developed enormously over the past twenty years, albeit largely within the scope of fairly short research projects. Around 100 existing and new greenhouse gas monitoring stations are now being linked up in Europe as part of the ICOS (*Integrated Carbon Observation System*) research network.

"At European level thematic centres will offer support. These will be able to provide services such as calibration of instruments and staff training. All researchers will have free access to monitoring stations and data."

Monitoring gas exchange

The aim is to monitor greenhouse gas exchange between ecosystems and the atmosphere by continual long-term coordinated monitoring. Local ecosystem stations and high-altitude meteorological masts are used to monitor areas over a radius of 200 – 300 km.

Professor Nilsson and his colleagues are participating in ICOS Sweden, which is coordinated by Lund University. Six monitoring stations are planned in Sweden. These will cover typical ecosystems – forest land, bogs and agricultural land.

"Five stations are already in place, of which three have meteorological masts. They have been fitted with instruments and will be ready to being continual monitoring from 2013."

All Swedish stations monitor flows of carbon dioxide in the air, some also flows of methane and nitrogen dioxide. Other data recorded include wind direction, wind speed, ground temperature and the amount of biomass in the ecosystem. The concentration of greenhouse gases at a height of 150 metres above ground level is also monitored.

"All this enables us to monitor air mass movements and variations in gas concentrations. It is thus possible to trace emissions, identify trends and take appropriate action."

COPY: NORA ADELSKÖLD

A 150 metre-high mast was airlifted into place by helicopter at the Svartberget monitoring station in Northern Sweden. Photo: Mikael Ottosson Löfvenius

IN SWEDISH

Utbytet av växthusgaser mellan jordytan och atmosfären har tidigare mätts sporadiskt i Europa. Men nu håller ett nätverk av mätstationer på att byggas upp.

www.slu.se/kunskapsbank/miljo-naturresurser

PHOTO: MARIA HEDBLOM

The researcher

Mats B. Nilsson, Professor of Forest Soil Science Biogeochemistry at the Department of Forest Ecology and Management, SLU, Umeå. PhD, SLU, 1992.

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COMBINING BUSINESS WITH PLEASURE

Professor David Wardle likes to spend time outdoors – in boreal forests and mountains as well as in rainforests. And best of all, he can combine this with his work as an ecologist.

Professor Wardle grew up in a mountainous area of South Island, New Zealand, and even at an early age he began to be interested in nature. Since then, his research has taken him to far-flung corners of the earth, from the temperate rain forests of his home country to the boreal forests and mountains of Northern Sweden.

Professor Wardle has lived in Sweden and worked at SLU since 1995. He appreciates the long days of Swedish summers, and says he can tolerate the winters because he can go skiing in the mountains. He often combines his field work with spending time in the great outdoors.

"It is true that love was what made me finally settle here, but working in the field has always been a great incentive for me, and here at SLU I have really had ample opportunity to do so."

Soil ageing stopped by fires

Professor Wardle is particularly interested in how plants, herbivores and predators above ground interact with organisms in soil, i.e. microbes and invertebrates. Among other things, he looks for general patterns in nature, e.g. how soil ages. The process occurs when weather, wind and plants drain it of nutrients over thousands of years.

Ageing is greatly affected by forest fires, and Professor Wardle and his colleagues have studied the ecosystems on some islands with differing histories of fires in some lakes in Northern Sweden. The frequency of fires affected both plants and soil organisms.

The Northern Swedish lake islands were compared with forests in Australia, New Zealand, Hawaii and Alaska, often with ecological disturbance other than fire.

"It was generally found that biological activity in soil declines in the absence of major disturbance; the availability of phosphorus and nitrogen falls, and in the end the forest stops growing."

The tree line and invasive species

Professor Wardle is also studying how the ecological characteristics of the landscape change with temperature along an altitude gradient. Among other things, he is looking for general patterns for nutrient cycles and nutrient availability in mountains in Europe, Chile, Colorado and New Zealand.

"The results may provide clues about factors influencing tree line position and scenarios for a warmer climate."

Professor Wardle goes back to New Zealand once a year, sometimes with his family. There he still has a number of projects at the University of Canterbury and the Landcare Research institute. Much of his work deals with invasive species, e.g. introduced plants, rats and deer, which are causing serious problems in his home country.

COPY: ANNIKA BORG

The researcher

David Wardle, Professor of Soil and Plant Ecology at the Department of Forest Ecology and Management, SLU, Umeå. PhD, University of Calgary, Canada, 1990.

Fellow of the Royal Society of New Zealand.
SLU's "Excellence Award", 2006.
Wallenberg Scholar award, 2010.
Editorial Board of several journals, including *Science*.

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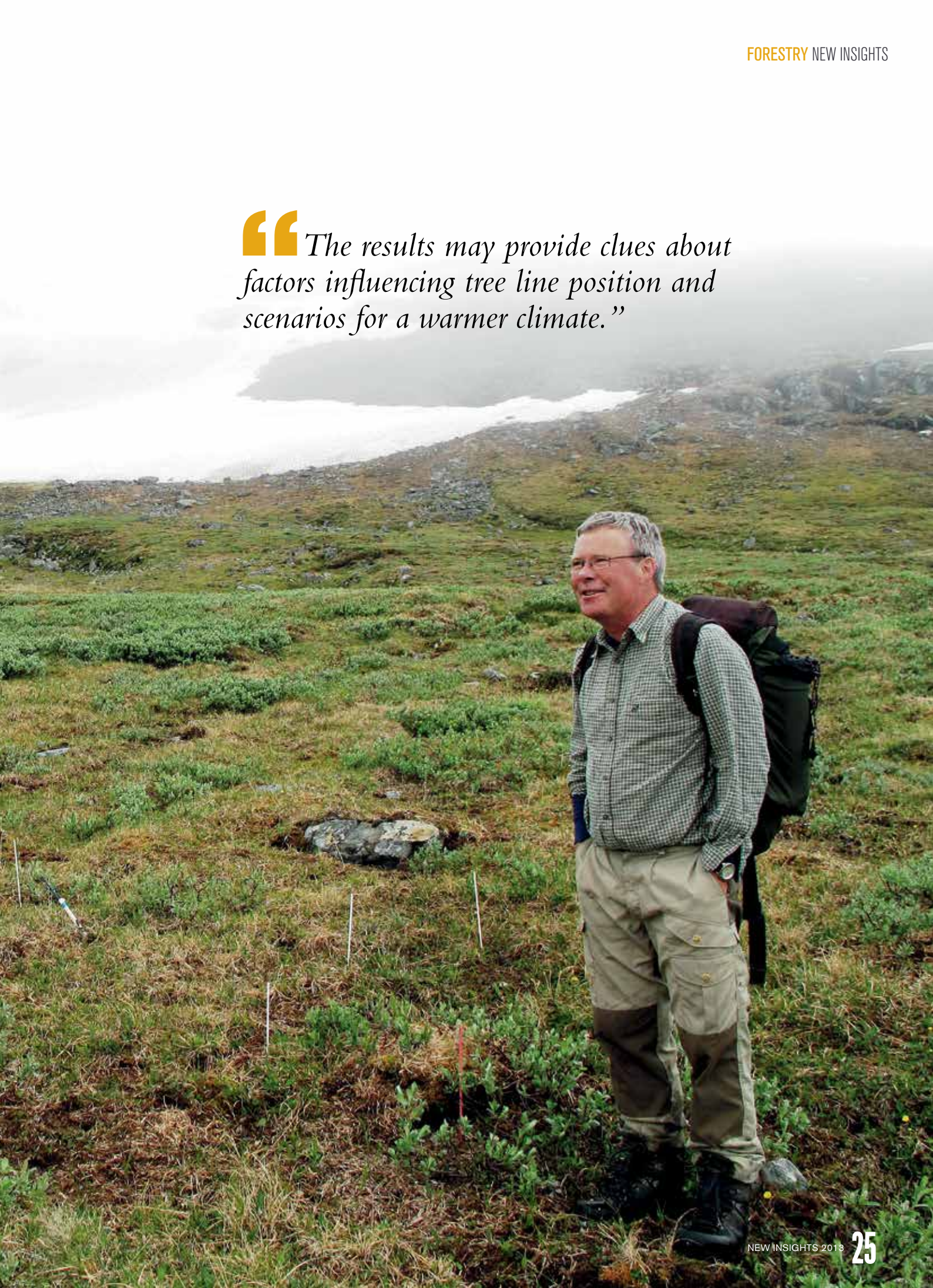
Professor David Wardle is studying the interplay between organisms above and below ground in the mountains of Northern Sweden. Photo: Paul Kardol

"The results may provide clues about factors influencing tree line position and scenarios for a warmer climate."



Large quantities of pesticide leach from banana plantations in Costa Rica, but leaching can be mitigated by international cooperation. Photo: Jenny Kreuger

Environmental toxins know no boundaries

After use on crops, pesticides have long moved freely between countries, carried by wind and water. This leakage is a major environmental problem. Attempts are being made to solve it by way of international cooperation.

Jenny Kreuger is Director of the *Centre for Chemical Pesticides* at SLU, which is part of *SLU's environmental monitoring and assessment.* She has been a member of various working groups in the EU, of which one surveyed the risk of pesticides being dispersed by air between areas and countries. That work has provided guidance for assessing whether or not various chemical pesticides can be approved in the EU.

Under a new EU directive, risks involved in using pesticides must be reduced, and this can be achieved if growers use integrated plant protection, whereby chemical methods are combined with biological and mechanical ones. This will also reduce the risk of substances leaking into water and air.

Jenny travelled to Costa Rica to discuss pesticides leaching from banana plantations. Costa Rica is investing heavily in eco-tourism, yet it is difficult to grow bananas without using any chemical pesticides at all.

The country's current environmental problems, including fish kills in watercourses, are reminiscent of the situation in Sweden 30 years ago. Solving these problems will require fact-gathering and analyses before any action can be taken. This applies both in Sweden and in Costa Rica. ■

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Oil plant and catch crop in one

In future field pepperweed, a biennial plant, may provide seed oil of a good technical quality. Undersown as an overwintering crop with barley, it helps to reduce nitrogen leaching in winter.

At present autumn oilseed rape is the only profitable oil crop in Sweden, but it can only be grown in the south of the country, since it is not fully hardy. Field pepperweed (*Lepidium campestre*), however, a cruciferous species that grows wild in Sweden, is well adapted to the Nordic climate. It has long, upright stems and gives a good seed crop. However, the wild plant has a tendency to lose its seeds before and during threshing, and neither the content nor the quality of oil from the seeds is good enough for profitable production.

Researchers at SLU in Alnarp have now attempted to modify the genes that control the seeds' tendency to shed, oil quality and content, so as to be able to produce a genetically modified field pepperweed with improved characteristics. They have used both conventional plant breeding and genetic engineering techniques.

Also being tried is a new cultivation system in which field pepperweed is undersown as a catch crop with spring cereals such as barley. The barley is harvested the first year, after which the field pepperweed overwinters and gives a crop of oil-rich seeds the following summer.

The domestication of field pepperweed is a sub-project under the *MistraBiotech* research programme. ■

COPY: NORA ADELSKÖLD

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Field pepperweed is now being genetically modified to become an oil crop. Photo: Dennis Eriksson

SLU goes global

About two-thirds of the world's poor live in rural areas where agriculture is crucial to their livelihoods. FAO predicts that by 2050 the world must produce as much as 70 percent more food to feed the global population. To achieve this increase in agricultural production in an environmentally, socially and economically sound manner, sustainable investments in research, higher education and training in the agricultural sciences are decisive. This is a key commitment for SLU.

To strengthen SLU's involvement in issues related to improving productivity in agriculture, food security and sustainable livelihood in low-income countries, the university has established the programme *Agricultural Sciences for Global Development* (SLU Global). The programme's mission is to coordinate and visualize SLU's competence in research, education and expert council within the frame of the Swedish Policy for Global Development.

One example of SLU Global´s work within the area of food security is the endeavor made possible by the 4.6 million Euros that the Swedish Ministry of Foreign Affairs allocated to SLU for research projects in collaboration with partners in Africa and elsewhere. The two-year long research projects financed by this allocation (*UD40*) include a variety of topics ranging from plant genetics and feed for Ugandan cattle (see description on the next page) to gender perspectives in agriculture and forestry.

COPY: MALIN PLANTING

www.slu.se/global

UGANDA:

Milking cows need better feed

Pastoralists are key contributors to Uganda's food security and 85 per cent of all milk and beef sold comes from indigenous cattle. However, good pasture and feed are crucial to livestock productivity. Insufficient nutrition leads to late maturity, low fertility, low offspring survival and long generation intervals.

Researcher Ewa Wredle at SLU is heading a project entitled *Improved efficiency of animal production in rural areas of Eastern Africa*. One issue is to increase feed availability for dairy cows in Uganda's agro-pastoral communities during periods of drought.

Many grazing lands in Uganda have deteriorated due to land degradation, overgrazing, and also a huge increase in human population. Other problems include climate change and prolonged periods of drought.

Christina Johansson from SLU is doing most of the practical work. She and Ewa are working with researchers from Makerere University to improve grazing strategies, and they are also seeking feed alternatives during drought. Their work includes analysing various plant species for protein and energy content.

Several dairy farmers are involved in the project, which will result in feed recommendations for Uganda's agro-pastoralists.

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GHANA AND KENYA:

Infections spread by urban fruit

Urbanisation in sub-Saharan countries is occurring more rapidly than anywhere else in the world, and demand for food is rising sharply in their growing cities.

People moving in from rural areas bring with them their knowledge of how to grow vegetables, providing households with their basic food requirements. Cultivation also represents a new source of income. But problems occur when crops are watered with contaminated water during dry periods.

A new project, headed by Professor Beatrix Alsanius at SLU, is studying the health risks and environmental effects of urban cultivation in Ghana and Kenya. The risks are of a biological nature, in the form of disease-carrying organisms, e.g. bacteria, viruses and worms.

There are also chemical and physical dangers, such as environmental toxins and glass fragments finding their way in among products.

The project is focusing on small and medium-sized towns, where communal water treatment facilities are lacking. It is being conducted in collaboration with national and international experts.

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UGANDA:
The Ankole cattle with its large and distinctive horn is a common sight in southwest Uganda.
Photo: Christina Johansson

GHANA AND KENYA:
Urban cultivation in Africa can provide a valuable addition to the family's food store and a boost to the household budget.
Photo: Agnes Andersson Djurfeldt

CHINA, VIETNAM AND ETHIOPIA:

Planting trend increases forested area

Afforested areas have grown rapidly in many countries over the past twenty years. Afforestation means planting trees in new areas. Often it is smallholders in the tropics who plant forest on their own land. In China and Vietnam this has resulted in a net increase in the area of forest, since the area planted has exceeded the area of natural forest felled. The composition of tree species and the biodiversity found in the new forest differ from those in natural forest, however.

In a project, headed by Mats Sandewall at SLU, three research teams in China, Vietnam and Ethiopia have analysed the effects of this increased planting. They have reviewed laws and forest policy, interviewed farmers and collected field data from two areas in each country.

In all three countries the right of individuals to farm their land has been strengthened at the same time as market conditions have improved. This has helped to engender interest in planting forest. However, local technical know-how is limited, and poor households are often obliged to cut trees down prematurely to cover immediate expenses. Small-scale farmers are also poorly organised and find it difficult to obtain proper payment for their timber. More affluent forest owners are able to invest for the longer term, on the other hand.

The researchers believe that this planting trend may slow down the global rate of deforestation. But if biodiversity is to be retained and poor households are to be lifted out of poverty, there will need to be a greater degree of consensus between local, national and global stakeholders.

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CHINA, VIETNAM AND ETHIOPIA:
Rice paddies are the predominant form of cultivation in the river valleys of northern Vietnam, whereas hill and mountain tops are rapidly being reforested. Fast-growing acacia and eucalyptus are mixed with tea plantations and other cash crops.
Photo: Mats Sandewall

PHOTO: CHRISTINA JOHANSSON

3 CAREERS ON EXPORT

Suneerat Aiumlamai

From PhD, SLU, Uppsala.
To Dean and Associate Professor at the Khon Kaen University (KKU), Thailand.
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Which experiences from SLU have contributed to your international career?
"During my stay at SLU I gained a lot of experience in my field of competence, reproduction of cattle. I also learned how to work in international collaborations.

The relationships with my colleagues and friends and other people from Sweden are now helping me make progress in my academic career."

Why choose SLU?
"The veterinary education and research at SLU have a very good reputation. Furthermore, people at SLU and in Sweden are generally helpful and friendly. During my years at SLU I learned a lot and got to know many people.

Also, the *Linnaeus-Palme Exchange Programme* leads to more exchange of employees and students between KKU and SLU. More people from KKU would now like to visit SLU for doctoral studies and research. These are good reasons to choose SLU."

Ingrid Öborn

From Professor of Agricultural Cropping Systems at the Department of Crop Production Ecology, SLU, Uppsala.
To Senior Research Fellow at the World Agroforestry Centre (ICRAF), Nairobi, Kenya.
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Which experiences from SLU have contributed to your international career?
"My experience of systems research and natural resource management has been crucial. Also, knowledge about integration between crop and livestock production, and now also trees, is essential for my new task.

Working in large multidisciplinary programmes, such as Future Agriculture and Mistra Biotech, I learned about research collaboration, programme management and communication with farmers, policymakers and other stakeholders. Experience of mentoring students and young scientists, as well as gender awareness, are highly appreciated at ICRAF. And without my international network, built up at conferences and in EU projects, I would probably not have been here today."

Why choose SLU?
"SLU concerns everybody as it contributes to sustainable global development. SLU's work in natural resource management, food, feed, fibre and bioenergy production, and urban and rural development is an essential part of a green economy in different parts of the world.

Early on, SLU researchers and students were linking production, productivity and environmental aspects together. This holistic approach is one of several very strong arguments for joining SLU."

Peter Holmgren

From Researcher at SLU in Umeå and Uppsala. FAO 1998 – 2012.
To Director General of CIFOR (Center for International Forestry Research) in Bogor, Indonesia.
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Which experiences from SLU have contributed to your international career?
"I became interested in international work during my undergraduate studies at SLU and carried out a minor field study in Ethiopia in 1987. I was also engaged in development projects in Asia and Africa. At FAO I lead the global forest resources assessment – entirely in line with my former research at SLU. I also was the leader of FAO's work on climate change. In 2012 I took up my current position as the first forester to lead CIFOR.

My studies and applied research at SLU, together with networking in the forestry sector, have enabled me to pursue a career in the international public sector."

Why choose SLU?
"SLU offers you every opportunity to develop a good platform for an international career, assuming your passion is for the green sectors.

You will need a postgraduate degree and to be firmly grounded in applied sciences. Governments increasingly require policies to be evidence-based, which is a tall order. But this also means that new decision makers will be expected to have a scientific background, which I think is excellent.

However, my advice is to focus on the major issues and combine biological studies with economics, languages and political science."

ANIMAL PRODUCTION

IMPROVING HEALTH, WELFARE AND BREEDING.

PHOTO: JENNY SVENNÅS-GILLNER

PHOTO: RAGNHILD MÖLLER

The researcher

Christer Bergsten, Professor of Systems Technology in Animal Production at the Department of Biosystems and Technology, SLU, Alnarp.

Veterinary hoof expert at the Swedish Dairy Association, co-operating with Viking Genetics.

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Lame cows a thing of the past?

Hoof diseases causing lameness are the main welfare problem for dairy cattle in Europe, and cost farmers large sums of money. Breeding selection, dry flooring, foot-baths and a future vaccine are some of the approaches being tried out by SLU researchers.

Swedish dairy cows have a low frequency of hoof diseases compared with other countries. This is because many of them are now kept in housing with slatted rubber flooring, thanks to Professor Christer Bergsten and his research team at SLU.

In the 1990s Professor Bergsten developed a registration system in which animal care specialists record cows suffering from various hoof diseases. This has resulted in an *international hoof health index*, which gives breeding bulls a breeding value for hoof health. This takes place in collaboration with a breeding company, and is now also being introduced in the other Nordic countries.

Worse in loose housing systems

"Lameness due to poor hoof health is nonetheless the commonest reason that Swedish dairy cows are put down or die early," comments Professor Bergsten. "And these problems quickly multiply in loose housing systems."

Large-scale loose housing systems pose a greater risk of injury and infection than stall barns, where animals are tied up. Another problem is that lameness is often not discovered and treated in time.

Of particular concern is the rise in *digital dermatitis*, which is a serious disease that has long plagued the US and many European countries. The disease first appeared in Sweden in 2004, but is now spreading rapidly among large herds in loose housing systems.

Professor Bergsten and bacteriologists at SLU have succeeded in identifying the spirochaete *Treponema* as the cause of digital dermatitis. The team is now searching for antibodies to the bacterium in blood and milk as an easy means of diagnosing the disease, and are also hoping develop a vaccine.

Alternative foot-baths

Digital dermatitis can be effectively treated by having the cows walk through a foot-bath containing copper sulphate in solution, but the chemical is also toxic to the environment. The researchers are therefore

Close-up of hoof infected with digital dermatitis. Photo: Christer Bergsten

Dirty cows in a loose housing system with wet concrete floor without drainage. Photo: Christer Bergsten

Clean and comfortable cows lying in a dry environment with slatted rubber flooring. Photo: Christer Bergsten

developing preventive treatment using foot-baths containing alternative, environmentally friendly disinfectants. It is also possible to treat infected hooves with antibiotics, but with the risk that the bacteria will become resistant to them.

Dry flooring essential

"The best approach of course is to prevent the disease by observing good hoof hygiene – there are far fewer problems with cattle housed in facilities with dry flooring. It is also important to avoid buying infected cows."

Professor Bergsten believes there is a fundamental need to improve hygiene, e.g. by better mucking out methods and soft, non-slip flooring, in order to reduce hoof problems in loose housing systems.

"It is untenable to try to cure the symptoms if the cattle can then wander around in a layer of manure and become reinfected – a question both of management and of cost."

COPY: NORA ADELSKÖLD

"The best approach of course is to prevent the disease by observing good hoof hygiene – there are far fewer problems with cattle housed in facilities with dry flooring."

IN SWEDISH

Klövsjukdomar som ger hälta är det största välfärdsproblemet för mjölkkor i Europa och kostar stora summor i lantbruket. Avelsurval, torra golv, fotbad och ett framtida vaccin är några av de vägar som forskarna prövar.

www.slu.se/kunskapsbank/husdjur

Professor Linda Keeling has studied behavioural abnormalities in chicks and other animals.

Animals need quality time too

The researcher

Linda Keeling, Professor of Animal Welfare at the Department of Animal Environment and Health, SLU Uppsala. PhD, University of Edinburgh, 1987.

Good animal husbandry is not just about reducing animal suffering and stress. Improving their life quality is just as important, also affecting profitability in animal production.

IN SWEDISH

En bra djurhållning handlar inte bara om att minska lidande och stress hos djuren. Det är lika viktigt att öka trivseln i djurens liv, något som också påverkar lönsamheten i djurhållningen.

www.slu.se/kunskapsbank/husdjur

"We know little about how to measure pleasure among adult animals, but we know that play in young animals is a good sign. In order to play, animals must not be hungry, thirsty or ill, nor must they be experiencing stress or fear," explains Linda Keeling, Professor of Animal Welfare at SLU.

For many years Professor Keeling has studied behavioural abnormalities in various kinds of animals, including pigs and poultry. One common factor permeates all her research on behaviour and welfare: finding out why animals react as they do in various situations, and how they perceive those situations.

Stimuli early in life

Professor Keeling emphasises that the first weeks in the life of most animals are particularly important. Animals that are in a stimulating environment and given company are better equipped to cope with difficult situations later in life.

Studies at SLU have shown that chicks should have access to perches and some form of litter so that they can learn to use these resources in a more natural way later on. The suppression of these and other natural behaviour is one of the main causes of stereotypies and poor welfare. Early experience in pigs has also been shown to influence later exploration and play behaviour, and so the potential to experience positive states.

Ensuring that farm animals live in a healthy environment will not require costly buildings. More straw and more appropriate social groups and handling may suffice to improve well-being.

"Animals that are not in a good state of mental health and consequently develop behavioural abnormalities represent a hidden cost to the farmer. Profitability may be jeopardised".

Happier is healthier

Earlier research concentrated mainly on remedying negative conditions such as disease, stress, pain, etc. Professor Keeling has also been focusing on the positive feelings that animals may experience.

Animals cannot talk, but they do have body language, which can reveal how they react in various situations – just like human beings.

"By taking a closer look at the way dogs behave in situations we perceive as positive, we can identify and confirm credible indicators. After that we can create tools to help us recognise when animals, including farm animals, are happy or content in other situations as well".

COPY: CARIN WRANGE

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SLU – at the heart of welfare science

A new welfare centre at SLU collates Swedish expertise on the health, care and behaviour of domestic animals.

The *Centre of Excellence in Animal Welfare Science* combines researchers in behaviour, physiology, genetics and medicine from the two leading animal welfare research groups in Sweden – at SLU and at Linköping University.

Both universities have a tradition of high quality innovative research, and contribute substantially to Sweden's leading role in European policy making by providing expert advice on animal welfare.

Four SLU professors are particularly active at the animal welfare centre:

Harry Blokhuis, Professor of Ethology, SLU, Uppsala

Linda Keeling, Centre Coordinator and Professor of Animal Welfare, SLU, Uppsala

Lena Lidfors, Professor of Ethology, SLU, Skara

Kerstin Uvnäs-Moberg, Professor of Physiology, SLU, Skara

www.slu.se/animalwelfare

The 39 participating countries are divided geographically into hubs. Professor Keeling is the coordinator for the Nordic countries.

Promoting good animal husbandry

The Aware research coordination network is working to bridge the gaps in knowledge of animal welfare between the countries of Europe.

The scope for conducting research or learning about animal welfare varies depending on where you are in Europe. So it is increasingly important to work at a strategic level within the EU, building networks and sharing knowledge.

SLU professors Harry Blokhuis and Linda Keeling were among the instigators of the EU Aware project (*Animal Welfare Research in an Enlarged Europe*), involving 39 countries and now led from the Czech Republic.

Uneven distribution

"It is a question of increasing awareness of welfare issues in agriculture among European researchers and teachers," says Professor Keeling, who is coordinator for the Nordic region and a member of the management committee for this EU project.

Research funding in the field of animal welfare is distributed unevenly between European countries. Swedish researchers are usually successful in their applications for EU funding, as are researchers in the rest of North-Western Europe. But countries in Eastern and Southern Europe, along with EU candidate countries, are falling further and further behind.

A survey has been made of the courses including animal welfare on veterinary and animal science programmes.

"In education, too, we found an uneven distribution between the regions," says Professor Keeling.

Helping self-help

The Aware project is using various means to even out these differences. For instance, over a thousand researchers, teachers and students have taken part in 17 road shows in 14 countries. Universities from old and new EU countries with similar research interests and education programmes are currently being twinned. Stakeholders transferring knowledge in the field of farm animal welfare in the Baltic region, East-Central Europe, and the Western and Eastern Balkans are being encouraged to collaborate.

Special researcher workshops provide opportunities to hone skills in networking, writing proposals, as well as management and administration of EU research projects. This work is being led by Professor Blokhuis.

An effective research coordination network is one of the fundamental ideas underlying the project. However, it takes time and energy to cross the thresholds, due to differing traditions of research funding and education.

"But we all gain from talking to one another and exchanging experience", says Professor Keeling.

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PORTRAIT

The researcher

Dirk-Jan de Koning,
Professor of Animal Breeding at the Department of Animal Breeding and Genetics, SLU, Uppsala. PhD, Wageningen UR, 2001.

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CHALLENGES IN A DUTCH PROFESSOR'S LIFE

Advanced techniques for DNA selection of breeding bulls and strong-legged laying hens are part of the everyday challenges faced by Dirk-Jan de Koning, Professor of Animal Breeding. Another daily challenge is to master Swedish.

Some two years ago, Dirk-Jan de Koning left the Roslin Institute in Edinburgh to take up a professorship at SLU. Dutch-born de Koning and his Finnish wife had spent a decade in Scotland and wanted to move on.

"We wanted to go to a place where we could really settle. The Netherlands is fine but too crowded, and we thought Sweden might be a good option. Of course I also knew that SLU offered high quality research in my field."

Professor de Koning and his wife now live in a house in the country close to Uppsala. They own a dog and a horse, since riding is one of his passions.

Important to know Swedish

Adapting to life in Sweden has not posed any major problems.

"I am far from fluent in Swedish, but I took Swedish classes and also managed to pass my hunting exam in Swedish. Right now I am attending SLU's leadership course, which is held in Swedish. Having a leadership position, I must make an effort to learn the language, and also be able to take part in discussions round the coffee table."

Professor de Koning finds that people in his department often communicate in English, but at faculty level they mostly speak and write in Swedish.

"I think this is a challenge for SLU, and changes take time. But we have many people in the departments who don't speak Swedish, and the organisation must be inclusive."

DNA selection for bull breeding

He is a project leader in the major MISTRA Biotech programme, where one of his projects involves selecting bulls for breeding using DNA information rather than traditional family-based criteria. This genomic selection may also be used for other animals, and even plants.

Another project includes the problem of broken legs among laying hens – caused because producing eggshells often deprives hens of calcium. Breeding more robust hens is the aim of a new study.

"I think it's important for SLU – and other universities – to perform applied as well as basic research. Neither should take precedence; applied research can lead to good basic research if we become more aware of the possibilities. It is also important to find useful collaborators, in the sector as well as at other universities." ■

COPY: MIKAEL JANSSON

Professor Dirk-Jan de Koning thinks that it is important to perform applied as well as basic research – one can lead to the other. Photo: Jenny Svennås-Gillner

Tasty pork without odour or pain

Throughout the world most boars are castrated at an early age, often without anaesthetic or painkillers. Castration eliminates the unpleasant smell, known as 'boar taint' otherwise given off by pork from boars when cooked. But there are alternatives.

Boar taint is caused by two substances, androstenone and skatole, which are formed and stored in fat when the boar reaches sexual maturity. Castration prevents sexual maturity and also suppresses aggressive boar behaviour.

Sweden has banned castration without anaesthetic as from 2016, and the EU wants to ban castration totally from 2018. This will necessitate the use of alternative methods, of which vaccination causes the animals least discomfort.

A vaccine against boar taint has been approved in the EU since 2009, and is widely used in countries such as Belgium, Australia, New Zealand and Brazil. Some Swedish pig farmers have already vaccinated their boars, but researchers Carl Brunius and Kristina Andersson regularly give presentations of the method around the country to encourage more farmers to try the method.

"The Swedish Board of Agriculture reimburses pig farmers for the cost of labour, vaccine and safety hypodermic needles," explains Kristina, "but abattoirs act as something of a brake on progress."

Early vaccination works well

The researchers have found that the vaccine works well under Swedish conditions, with the cross-breeds that are reared here. They found that early vaccination, i.e. at the age of 10 and 14 weeks, shuts down the testicle function and the occurrence of boar taint as effectively as standard vaccination, which is carried out at 16 and 20 weeks.

Early vaccination also makes things easier for the animal keeper; aggressive boar behaviour can be suppressed since the boars do not reach sexual maturity. However, the boars' greater growth potential is not exploited as effectively when vaccination takes place early.

"Vaccination is a more animal-friendly alternative, which prevents both boar taint and aggressive behaviour as effectively as castration," says Carl. "Moreover, studies have revealed no difference in meat quality."

COPY: NORA ADELSKÖLD

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The unpleasant smell from boar pork when cooked, can be eliminated by vaccination, instead of castration, of young pigs. Photo: iStockphoto.com

Breeding arctic char for aquaculture

Jet of eggs from one of the female arctic char in the breeding programme. Photo: Bo-Sören Wiklund

A breeding programme for arctic char has resulted in a fish that grows three times faster than the 'original'. This is of great importance for the profitability of the burgeoning arctic char farming industry.

Fish breeding research at SLU aims to improve fish characteristics that are central to economically and ethically sound fish farming. It is important that fish grow quickly, have good body shape, and also that they have time to grow big enough before they reach sexual maturity. Future breeding research will include studying how well these fish can grow on vegetable-based feed.

The Swedish breeding research programme and the interest in farming arctic char began in the early 1980s. From the second generation onwards, these farmed fish have gone under the name *Arctic superior.*

SLU researchers are currently identifying stress-tolerant individuals with a good rate of growth in a breeding population. They are also comparing stress tolerance and aggressive behaviour in arctic char bred over seven generations for rapid growth with populations in which no selection has taken place. A further aim is to examine whether there is a correlation between physiological stress response, behaviour and pigmentation, as previously seen in other salmonids.

The researchers are working under the auspices of the new *Swedish Centre for Aquaculture,* a joint showcase for the aquaculture research being conducted by SLU and the University of Gothenburg.

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4 the future
INTERDISCIPLINARY RESEARCH PLATFORMS

Fitting the pieces together

Four interdisciplinary platforms, for future forests, agriculture, animals and urban development, have been created at SLU. They enable researchers to provide society with a more holistic picture of global issues.

Global challenges and national needs both underscore the importance of intensified policy-relevant research, developing and combining the strengths of the four faculties at SLU.

Four *Research Areas for the Future* have been formed to enhance the interplay between research groups and disciplines, and to address complex issues holistically. They are interdisciplinary platforms for internal and external interaction, coordination of research projects, and formulation of major grant proposals.

"This enables SLU to adopt a strong role as coordinator of national and international research programmes and to direct research towards the most burning issues of today," says Pro Vice-Chancellor Johan Schnürer.

Scientists, social scientists, humanists and design scientists are working with sector representatives to identify research needs, and to make interdisciplinary analyses and syntheses. ■

COPY: NORA ADELSKÖLD

Sector representatives listening to researchers at one of Future Forests' excursions. Photo: Annika Mossing

Interaction between researchers from different disciplines at a Future Agriculture conference. Photo: Pelle Fredriksson

"The Future platforms help to fit the scientific pieces together to form a complete picture."

Pro Vice-Chancellor Johan Schnürer
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4 research platforms for the future

ILLUSTRATIONS: FREDRIK SAARKOPPEL

Future Forests

The programme provides new understanding for sustainable management of forests in a changing future. This knowledge is needed to increase the supply of forest biomass, for biodiversity conservation, recreation, water resources, and to mitigate climate change.

The concept of adaptive forest management is being studied as a tool to adapt forestry to meet global challenges and to facilitate the transition to a green bio-based economy.

What are the unique features of your interdisciplinary research programme?
"Sweden has a long tradition of basic scientific research and of applied forestry research. But the forestry sector is now facing an ever-increasing demand for forest ecosystem services. Future Forests is further developing this research, to be better able to produce the knowledge demanded by decision makers at various levels in society."

What positive effects for SLU and society do you think this will yield?
"Future Forests has helped to clearly reveal the challenges faced by the forestry sector. Demands on forests will continue to grow, which involves difficult choices between priorities for our decision makers in deciding how forests should be used.

SLU's sectoral responsibility includes providing society with knowledge about sustainable land use. Future Forests is making a key contribution." ■

Professor Annika Nordin
Programme Director

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Future Agriculture
– livestock, crops and land use

In this strategic platform, SLU researchers from various scientific fields are working with other research institutions, the agricultural sector, authorities and non-governmental organisations to meet the future challenges facing agriculture.

The focus of Future Agriculture is to research and communicate on environmentally, economically and socially sustainable agricultural production and land use in Sweden.

What are the unique features of your interdisciplinary research programme?
"Our tools are seminars, courses and research projects. The aim of all these activities is to cross disciplinary and faculty borders and to apply a futures perspective.

We want to help address complex global challenges arising from population increase, climate change and the need for energy transition by creating a fruitful relationship between natural and social sciences."

What positive effects for SLU and society do you think this will yield?
"Our platform is an open discussion forum that aims to increase awareness of possible routes to sustainable production and consumption patterns. We try to avoid adopting dogmatic positions on certain technologies, scales and production systems." ■

Professor Erik Westholm
Programme Director

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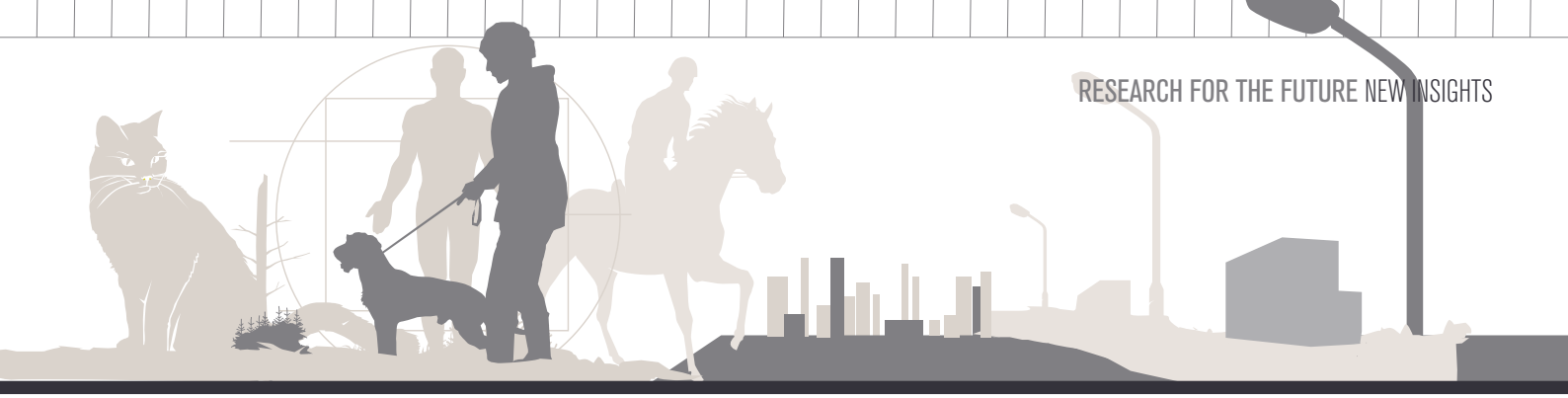

Future Animal Health and Welfare

This interdisciplinary programme supports society's sustainable relationships with animals. It has a particular responsibility for cats, dogs and horses and a particular focus on the impact of lifestyle on health and welfare.

Healthy and diseased animals alike are studied to achieve the programme's vision: good health and welfare for animals and humans.

What are the unique features of your interdisciplinary research programme?
"The programme is unique thanks to its broad perspective, in which knowledge from several scientific disciplines is interleaved, and in which the focus is on the multifaceted importance of animals to human health and wellbeing. The programme mainly concentrates on how lifestyle, often shared by humans and animals, affects health and welfare."

What positive effects for SLU and society do you think this will yield?
"The lifestyle theme provides fresh scope for collaboration, and the interdisciplinary research needed to bolster SLU's future competitiveness is stimulated. New insights are created when our expertise in fields such as urban planning, biology, animal science and veterinary medicine is brought together." ■

Professor Bodil Ström Holst
Programme Director

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FUSE – Future Urban Sustainable Environment

Rapid global urbanisation is expected to spur insistent competition for land. The compact city is a way of countering urban sprawl, and cities also need to adapt to new urban lifestyles and climate conditions.

As urban density increases, we must ensure high quality of life and provide ecosystem services and agricultural land for the production of food and fibres.

What are the unique features of your interdisciplinary research programme?
"The programme covers everything from nutrient uptake by plants to climate issues. Systems theory as it relates to energy and material flows between urban and rural areas is important, along with planning, policy, design, sociology and environmental psychology. Landscape architecture has a unique opportunity to contribute to sustainable urban development, since it has a holistic perspective and temporal depth."

What positive effects for SLU and society do you think this will yield?
"FUSE contributes interdisciplinary knowledge for sustainable urban development in many of SLU's core fields.

We are working to achieve several of the Swedish environmental objectives in cooperation with the National Board of Housing, Building and Planning. Statistics Sweden has also shown an interest in the issues we address, and we are already working jointly with a number of enterprises, municipalities, county administrative boards and other universities." ■

Master of Architecture Caroline Dahl
Project leader

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SLU in brief

Vision
"SLU is a world-class university in the fields of life and environmental sciences."

Mission statement
"SLU develops the understanding and sustainable use and management of biological natural resources. This is achieved by research, education and environmental monitoring and assessment, in collaboration with the surrounding community."

Education, students and employees in 2012
42 degree programmes
3 935 full-time students
3.6 students per graduated teacher
714 PhD students
3 080 full-time employees

Four faculties
The Faculty of Forest Sciences
The Faculty of Natural Resources and Agricultural Sciences
The Faculty of Veterinary Medicine and Animal Science
The Faculty of Landscape Planning, Horticulture and Agricultural Science

Locations
SLU's main campuses are located in Alnarp, Skara, Uppsala and Umeå. Research and education, as well as environmental monitoring and assessment, are carried out at several research stations, experimental parks and educational centres all over the country.

Collaborations
Cornell University, Euroleague for Life Sciences, China Agricultural University, Penn State University, Wageningen University, Global Challenges University Alliance, etc.

Highly ranked
The prestigious Leiden Ranking 2011/2012 places SLU among the 200 best universities in the world. The Leiden Ranking measures the scientific performance of 500 major universities world-wide. Among Swedish universities SLU is second best, when ranking is based on *Mean normalised citation score,* or third, when based on *Proportion top 10 per cent publications*.

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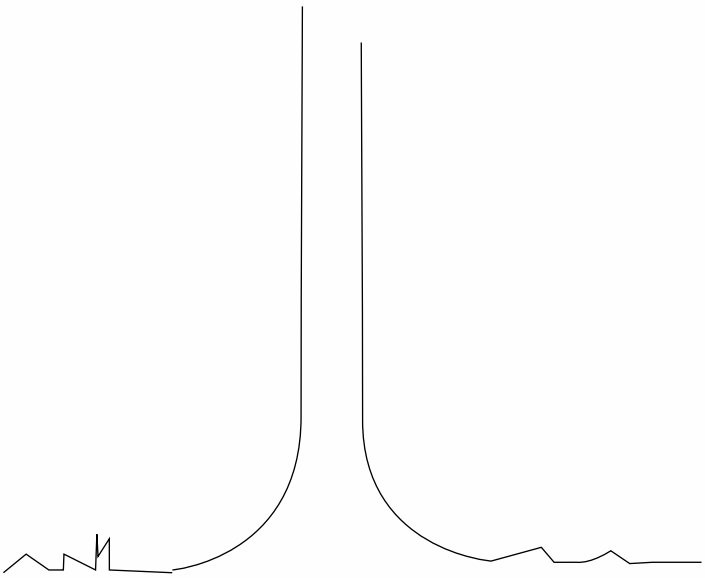
Sveriges lantbruksuniversitet
Swedish University of Agricultural Sciences

Knowledge for a sustainable future

Where ideas grow...

…
innovations
emerge. With a passion
for science, we support our
researchers who aim for the sky with their
results. Young, hungry and competitive
companies grow, assisted by our
green sector business knowledge.
For the benefit of society.



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