Think.

An inquisitive magazine from Umeå University × 2020

FUTURE GENERATIONS IN OUR HANDS

UNDERGROUND THREAT TO OUR NATIONAL PARKS

GENETICALLY MODIFIED FISH ASSISTING IN THE FIGHT AGAINST CANCER

A SOCIALLY, ENVIRONMENTALLY AND FINANCIALLY

SUSTAINABLE WORLD

FROM FILTHY INDUSTRY TO ECO-FRIENDLY COMPANY

UMEÅ UNIVERSITY

Photo: Ulrika Bergfors and Mattias Pettersson

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Think is the Umeå University magazine focusing on research. This issue of Think focuses on research that contributes to a sustainable world — from a social, financial and environmental perspective.

Publisher: Gunilla Stendahl
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Phone: + 46 90-786 50 00
Editorial board: Ulrika Bergfors, Camilla Bergvall, Johanna Fredriksson, Jonas Lidström and Inger Nilsson.
Cover photo: Camilla Hällgren
Translation coordinator: Anna Lawrence
Production: Inhousebyrån, Umeå University
Printing: Taberg Media Group

UMEÅ UNIVERSITY

Sustainability requires active responsibility

On a global level, society is facing a series of major challenges. We're talking about climate change that will dramatically change the lives of many people all over the world, armed conflicts that are forcing people to become refugees, threats against democracy, ongoing depletion of the Earth's resources, Brexit and a new European game plan. In Sweden, we're facing major challenges as regards skills supply in many vital public areas – schools, the police, and not least health care.

One thing that many of these challenges have in common is the fact that they revolve around sustainability and sustainable development.

UMEÅ UNIVERSITY'S new vision, which came into force at the start of the year, focuses on three general development areas that indicate the direction the university will be taking in the immediate future; Responsibility for the future, Collaborative development of knowledge, and Competitive edge and pride. By 'Responsibility for the future', we mean that the university can and should play an active part in our future by providing new knowledge and well educated students. Umeå University's broad efforts in respect of research and education mean that we have everything we need to tackle many of society's challenges in earnest, and the UN's 2030 Agenda is providing us with a clear guide. The seventeen sustainable development goals adopted by world leaders in 2015 are ambitious and universal, and they aim to bring about a world that's socially, environmentally and economically sustainable by 2030.

THIS ISSUE of Think focuses on sustainability and highlights research fields that are all linked with the seventeen sustainable development goals in the 2030 Agenda. Some of the university's researchers share their research output, ideas and experiences on topics such as future energy sources, the impact of climate change on health, new forms of cancer therapy, antibiotic resistance, what the actual concept of sustainability involves and how we as individuals can live more sustainably. Read and be inspired!

Hans Adolfsson
Vice-Chancellor of Umeå University

About the cover picture

CAMILLA HÄLLGREN is an artist and docent at the Department of Applied Educational Science. The cover *The kids won't notice* (courtesy of Galleri Andersson Sandström), is part of a sustainability and climate change series.

"The ideas for my pictures usually resonate in contemporary, current phenomena, such as the environment and climate change. This picture is all about sustainability and responsibility, and can be interpreted as a serious comment – albeit with a little humour – on mankind's recklessness with the only planet we have."

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FROM FILTHY INDUSTRY TO ECO-FRIENDLY COMPANY
Ann-Kristin Bergquist studies the development of climate transitions in trade and industry. She has followed Rönnskärsverken's promising journey of sustainability.

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CHEMISTRY THAT TURNS BIOMASS INTO PETROL

Professor Jyri-Pekka Mikkola and his colleagues have worked together to invent a groundbreaking process for turning bio-based ethanol into petrol and diesel. The biggest challenge is now faced on a business level – finding funding and partners to put the system into production.

Text: **Jonas Lidström** Photo: **Mattias Pettersson**

Jyri-Pekka Mikkola is a professor of chemistry at Umeå University and one of the co-owners of Eco-Oil AB, a company based on a chemical innovation that will make it possible to produce synthetic petrol out of ethanol.

Jyri-Pekka Mikkola

"I decided right from the outset that I was going to implement a secret project. Something really difficult that could possibly change the world," he says.

IT ALL began around 2009. That was the year in which the Swedish government invested specially in 20 or so strategic research fields in order to produce world-leading research in vital fields. Umeå University, the Swedish University of Agricultural Sciences and Luleå University of Technology all applied to carry out research in the field of energy, culminating in the Bio4Energy research programme.

"This research programme gave us basic resources that were absolutely crucial," says Jyri-Pekka Mikkola.

FOLLOWING AN extension of the research programme in 2015, Bio4Energy has now been running for almost a decade and has achieved good results with development of sustainable biorefinery processes.

But alongside these official activities, Jyri-Pekka Mikkola's research team has also worked on a secret project: making petrol out of renewable raw materials.

"When you're working on something radical, *game changer* technology, you have to keep things quiet. If you don't, your discovery will be stolen, copied or crushed by some powerful force," he explains.

THE FIRST – and biggest – challenge was to develop a new material, a catalyst, with very specific properties: reacting with ethanol in a way that 'converts' the alcohol molecules into petrol or diesel.

"It took us a long time to refine the materials to make the product just the way we wanted it," says Jyri-Pekka Mikkola.

THE RESEARCH team has subsequently developed a process centred on the new catalyst materials. The basic concept involves petrol and diesel production taking place not at huge refineries, but at facilities about the size of a standard shipping container.

"This technology will make it possible to produce fuels on a much smaller scale,

The material we devised looks like a white powder. A single grain has a surface area equivalent to an entire football pitch.

in the locations where the raw materials can be found. Larger farms or community associations could become self-sufficient and produce their own fuel."

IF THIS vision becomes reality, this won't just involve a green transition for fuel production: it will result in the restructuring of the entire industry.

"When I carried out a basic calculation using a series of assumptions, I found we'd need around 2,000 containers of this kind to convert Sweden from fossil fuel to renewable fuel."

As yet, there's still a lot of work to be done before this vision can become reality. Jyri-Pekka Mikkola is confident yet humble as the project enters its most delicate phase.

"It all works on a technological level. The difficult thing is to gain credibility so that we can get some real money behind us."

He says he's worked extensively on identifying the advantages and disadvantages of renewable hydrocarbons versus electric drives. As a result, he reckons producing batteries and electric powertrains takes up too much energy, while extraction of rare metals comes at a high price – both environmentally and socially.

THE DISADVANTAGE of large-scale production of bio-based fuel is that many trees that bind carbon dioxide would have to be harvested and turned into ethanol for the dream of phasing our fossil oil in favour of a renewable, circular system to come true.

"It would take time to regrow all that vegetation, but what else can we do?" asks Jyri-Pekka Mikkola rhetorically.

"All combustion processes produce carbon dioxide that is realeased. It's unfortunately unavoidable." ✖

Lack of trust in politicians presents serious threat to climate work

People who don't trust politicians or the political system, or who live in communities where trust is generally low, tend not to support taxes on fossil fuels, regardless of whether they're climate change deniers or believe that climate change is dangerous and man-made.

These are the findings based on survey data from a representative selection of populations in more than 20 European countries.

Photo: Melker Dahlstrand/ the Swedish Riksdag

Spotting ill-health through new tool

Umeå researchers have devised method support that will help employers recognise the early warning signals when their staff are getting stressed.

Hans Wiklund new University Director

Hans Wiklund from Härnösand will be the new University Director at Umeå University. He starts on 1 March 2020.

Photo: Örjan Leek

Siberian waterways release greenhouse gases

New research shows that a warmer climate and thawing of permafrost is causing an increase in greenhouse gas emissions from rivers and lakes in Western Siberia.

Photo: Egor Istigechev

Training elite trainers in Umeå

A new elite trainer programme will be starting at Umeå University in the 2020 autumn semester. This new trainer programme is a part of a National Sports University initiative.

Efficient lighting without rare precious metals

Researchers at the universities of Umeå and Kyushu have demonstrated that it is possible to achieve strong, efficient lighting from light-emitting electrochemical cells based on entirely organic materials.

Photo: Mattias Pettersson

Photo: Mikael Lundgren

The Design Matters exhibition will be running until the 2020 Easter weekend. Take a look at bildmuseet.umu.se/en for more pictures, information and opening hours.

THE BEAUTIFUL IS FOUND IN THE SUSTAINABLE

The Design Matters exhibition at Bildmuseet provides food for thought. What is function, beauty and sustainability?

The exhibition presents ten international designers and design teams. All looking ahead to new ways of producing and using consumables, furniture and fashion.

Sustainability crops up on many levels: in the choice of materials, for example.

"One clear example is presented by the utility items and furnishings by designer Maurizio Montalti, which he grows from fungal mycelium. Another comes from Jesper Eriksson, who makes furniture out of black coal," explains curator Anders Jansson.

Black coal is perceived as ugly, dirty and unpleasant. But could design help us see coal as a sustainable natural material that's just as beautiful as marble?

"Visitors have told me that the exhibition has helped them see new opportunities and beauty in places they hadn't thought of before," says Anders Jansson.

Supporting the transition in industry

The mining and minerals industry, including cement and lime production, is responsible for around eight per cent of total carbon dioxide emissions in Sweden. The industry is undergoing a transition towards more sustainable production.

This was why the Centre for Sustainable Cement and Quicklime Production was set up at Umeå University in January 2019. Its objective is to produce new knowledge and support the industry through this transition. Another objective is to establish a strong network of researchers.

Thirty people from industry and academia are playing an active part in this work at present. The centre has received research funding for various projects and embarked upon two new PhD projects.

The sore point in malaria parasites found

Malaria is caused by the mosquito-borne parasite *Plasmodium* and kills almost half a million people each year. Consequently, developing new drugs is much needed. Oliver Billker and his research group has now identified seven metabolic routes the parasite needs to infect the liver, in which the parasite rapidly propagates to invade our red blood cells causing malaria. Since most other malaria drugs are aimed at the blood stage in the life-cycle of the parasite, the seven metabolic stages seem particularly promising as targets for new drugs.

"There are less parasites in the liver than in the blood, which would reduce the likelihood of causing drug resistance. That's why the discovery of new drug targets in the liver stage is important," says Oliver Billker.

SUSTAINABILITY REQUIRES A SYSTEMATIC APPROACH

As Chief Operations Officer for the H&M Group, Helena Helmersson bears a great deal of responsibility for ensuring that this fashion giant achieves its social sustainability objectives and establishes a circular business model by 2030.

Text: **Jonas Lidström** Photo: **Mattias Pettersson**

Helena Helmersson has returned to Umeå School of Business, Economics and Statistics for a visit. She studied economics there herself more than twenty years ago. "Umeå University is very close to my heart. I really enjoyed my time there and it's given me a brilliant foundation for the rest of my life."

Helena Helmersson has graduated from Umeå University with a degree in economics. She's been working for the H&M Group for 22 years now, and for a long time she's been a driving force in turning sustainability into a core issue.

You're here at Umeå University to receive an award presented to influential leaders. In what ways have you been influential?
"I and many others have helped to integrate sustainability in the H&M Group's business. When I took over as head of sustainability, this field still wasn't entirely mainstream. They had a talented sustainability team, but not all countries and divisions had sustainability targets that they themselves pursued. But now this is certainly the case."

How far do you think the H&M Group has come on its journey towards becoming a sustainable company?
"I don't think sustainability is something you can ever stop working with. But let's look at the fair pay issue, for example. We used to go over to countries where we produce a lot of our goods, meet their prime ministers and try to persuade them to increase their minimum wage. But nowadays, we have an entire system in place where we actually get workers on the factory floor to negotiate their own pay; and at the same time, as a company we've changed our approach to negotiating prices with subcontractors. There's still a lot left to do before we've achieved our objective of making sure all workers receive a living wage, but it's clear that things are moving in the right direction."

What other fields are there in which you still need to see improvement?
"A lot of effort is currently being invested in moving towards a circular business model. This means that all the fibres we use have to be recycled. Nowadays, some of our collections are based on recycled fibres. But new innovations are needed if we are to go all the way. We also need to come up with scalable techniques to extract dyes out of textile fibres and separate fibres in material blends. We share these needs with the industry as a whole."

During your visit to Umeå University, you also gave a guest lecture to students and alumni entitled Leadership in a changing world. How are sustainability issues placing new demands on leadership?
"As a manager, you have to adopt a systematic approach. Implementing an activity as part of your business isn't enough. You have to change the entire agenda at the same time: consider conduct within the organisation, define other types of targets, choose the right partners. You have to think of all the parameters." ✖

GENETICALLY MODIFIED FISH ASSISTING IN THE FIGHT AGAINST CANCER

Maréne Landström, Professor of pathology at Umeå University and her research team have genetically modified zebrafish to discover molecular mechanisms relating to how a certain type of prostate cancer spreads and becomes malignant. This could result in better treatment and more effective drugs to treat prostate cancer.

Text: **Nils Fredriksson**
Photo: **Mostphotos/Christian Weiss and Mattias Pettersson**

Prostate cancer is the most common form of cancer in men globally; and the disease appears to become even more prevalent in the coming years.

As it's associated with the western diet, which is becoming increasingly common in developing countries as well.

Maréne Landström

"This is why being able to recognise aggressive forms of prostate cancer is highly valuable. There's a lot of evidence to indicate that ordinary forms of cancer also use molecules in similar ways, so our research may also be of importance to other patient groups," says Maréne Landström, who carried out the study together with Jonas von Hofsten at Umeå University.

THE RESEARCH that led to the breakthrough began in 2012, when she received a large grant. This gave her the opportunity to recruit doctoral students to investigate signalling molecules that have a part to play in inflammation and tumour progression. Pilot trials revealed that the special protein TRAF6 was important in the signalling chain resulting in prostate cancer becoming aggressive.

BY ANALYSING the expression and function for TRAF6 in both tissue samples from men with prostate cancer and genetically modified zebrafish – with a great deal of assistance from the genome editor CRISPR-Cas9 – researchers have been able to position TRAF6 as a new and important key protein in the signalling chain for the Wnt3 function in Wnt3a, a growth factor that promotes tumour growth and cancer spread.

"We've found a new piece of the puzzle that makes it possible to understand molecular mechanisms in the progression of cancer more closely. In the long run, this may make it possible to recognise aggressive tumour cells in patients at an earlier stage and help to bring about new, improved treatments. Many prostate cancer treatments nowadays result in side effects and relapse, but we hope our discovery will help to remedy this. This greater understanding will also make it possible to develop new drugs in future."

MARÉNE LANDSTRÖM and her research team are now continuing their studies into TRAF6 and its significance as regards prostate cancer. Karthik Aripaka, a member of the team, completed his doctorate in late 2019, and in 2020 the researchers are investigating the role of the lymphatic system and blood vessels in the spread of prostate cancer. The research team will be using zebrafish for their trials here as well.

"The advantage of zebrafish is that we see results within six to twelve months. With mice it takes about three years to get

similar responses. The transparency of the fish makes it easy to monitor the spread of the metastases."

Maréne Landström is also running another project testing a potential new cancer drug. Based on her previous research, this research team has found promising new biomarkers for aggressive prostate and renal cancer. TRAF6 has an important part to play here as well, but in a different part of the signalling chain. ✖

Prostate cancer is the most common form of cancer in Sweden. This disease mainly affects older men — around half of sufferers are over 70, and only a small number are under 40 at the time of diagnosis. Prostate cancer accounts for a third of all cancers in men. Around 10,000 new prostate cancer cases are detected every year.

Source: Swedish Cancer Society

Viruses – a weapon against cancer

Adenoviruses cause infections, usually in the airways. But this group of viruses can also be an effective weapon against cancer.

A team of researchers in Umeå has now detected a new type of mechanism that provides new opportunities to develop virus-based cancer therapies.

Text: **Camilla Bergvall** Photo: **Andreas Lenman**
Illustration: **Mostphotos**

Viruses are specialists when it comes to entering cells and propagating, so they can be used in different ways to kill cancer cells. A viral infection in a tumour can activate the whole body's immune defences against cancer cells. It's also possible to 'arm' viruses with different genes that prevent cancer cells from developing resistance to various drugs.

Annasara Lenman

"Targeting viruses specifically against cancer cells has presented us with a major challenge. Most of the adenoviruses tested to date have just one type of fibre to attach to cells," explains Annasara Lenman, one of the Umeå researchers at the Department of Clinical Microbiology.

ADENOVIRUS TYPE 52 (HAdV-52) is one of a small number of adenoviruses with two different fibre protein types on its outside used to bond to target cells. Working in partnership with researchers at Imperial College, London, a world leader in the field of glycobiology, Annasara Lenman has now been able to demonstrate that the shorter fibre bonds to an unusual type of carbohydrate-based receptor, polysialic acid.

"As polysialic acid is overexpressed in cancer cells in the brain and lungs, for instance, this paves the way for new opportunities to use HAdV-52 to treat similar types of cancer," she says. ✖

The Lancet countdown

'The Lancet countdown on health and climate change' is a project involving around 100 researchers all over the world who specialise in health and the environment.

They're looking at the impact of climate change based on 41 indicators relating to health and the environment.

The 'countdown' refers to the time remaining until 2030 so we can change course in vital areas according to the UN's 2030 Agenda.

A report is published each year in the scientific journal The Lancet.

SERIOUS HEALTH CONSEQUENCES

The world is facing major challenges as regards ongoing and imminent climate change. This is affecting human health, and the situation is serious.

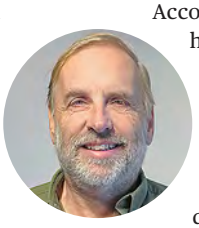
"We can expect more children to die from acute asthma attacks if the air becomes more polluted," says Peter Byass, Professor of global health at Umeå University.

Text: **Johanna Fredriksson** Photo: **Pixabay and Margaret Byass**

A project by the name of The Lancet countdown has been running since 2016 in order to provide a clearer view of development of the health situation on a global level, and how this is influenced by climate change. Around 100 researchers from 35 institutes all over the world are looking at health and the environment on the basis of 41 different indicators. Umeå University is the only Swedish higher education institution to take part.

"Umeå has a long tradition of looking at health issues in a global context," says Professor Peter Byass, leader of the team in Umeå. Docent Maria Nilsson and Professor Joacim Rocklöv are also members of the team.

THE REPORT for 2019 focused in particular on child health, a very topical field given how climate issues have engaged the younger generation over the past year.



Peter Byass

According to Peter Byass, children have every reason to be worried. We can already see how climate change is causing natural disasters, heatwaves and polluted air.

A CITY like Umeå has good air quality, but the air quality in cities like Delhi and Shanghai is poor.

"You can barely breathe there. Just think of all the children who have to grow up in that kind of environment. This will have serious consequences," says Peter Byass, outlining a scenario where more children will die because of air pollution.

"Greta Thunberg and her friends are absolutely right to raise their voices."

BUT CHILDREN aren't the only ones who are suffering. More frequent heatwaves are a consequence that's affecting the elderly to a greater extent. A factor that has shocked researchers.

"Exposure to heatwaves has kept increasing," says Peter Byass, explaining that fewer than 10 million people in the world had experienced heatwaves just five years ago. Last year, this figure stood at 220 million.

"Climate change is affecting us all."

RESEARCHERS WORKING on The Lancet countdown are providing lots of different perspectives, but they're all unanimous.

"There's no doubt that we're seeing climate change, and it's highly likely that this threat to human health will have severe consequences. These are serious threats," says Peter Byass, who encourages everyone to help make the changes that they can assist with, small or large ones, while also emphasising that global partnerships are required in order to achieve real change. Immediately.

"This is an urgent matter. The longer we wait, the more expensive it'll be." ×

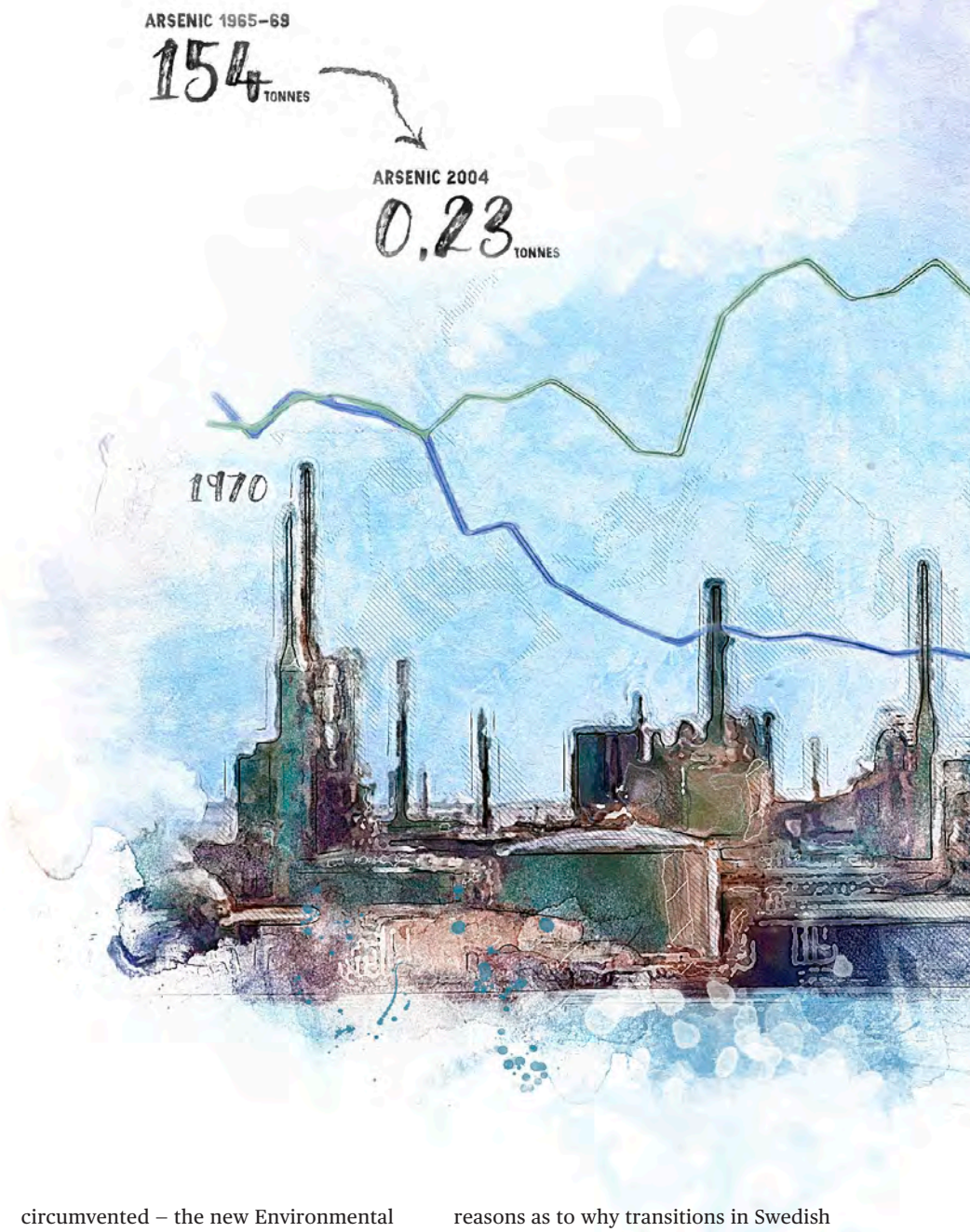
FROM FILTHY INDUSTRY TO ECO-FRIENDLY COMPANY

The Rönnskärsverken journey of sustainability from the 1960s to 2000 is almost like a fairytale. The environment benefited – but so did the company. What can a world facing a climate crisis learn from Sweden, and what do we actually need if we are to bring about change?

Text: **Johanna Fredriksson** Photo: **Mattias Pettersson** Illustration: **Ida Åberg**

Ann-Kristin Bergquist studies the development of climate transitions in trade and industry, nationally and internationally. "We don't stand a chance to meet the climate targets without a global agreement."

Sweden has reduced its carbon dioxide emissions per capita. From 11.48 tonnes in 1970 to 4.5 tonnes in 2014. In the same period, China has gone from 0.9 to 7.5 tonnes.



Ann-Kristin Bergquist is a docent in economic history at Umeå University. Her research focuses primarily on working from a historical perspective to understand criteria and obstacles to environmental and energy transitions in trade and industry, particularly heavy industry.

One of her research fields has involved the development of the Boliden Rönnskär smelters in northern Västerbotten, which was Sweden's 'filthiest industry' in the early 1970s as its ore contained singularly high levels of sulphur and heavy metals.

Since then, Rönnskär has reduced its emissions of heavy metals by 99 per cent. While also more than doubling production.

"This cost Boliden a lot of money in the short term, but in the long term it turned out to be a profitable transition," says Ann-Kristin Bergquist, explaining that the same thing also happened in the pulp and paper industry, which she's also studied.

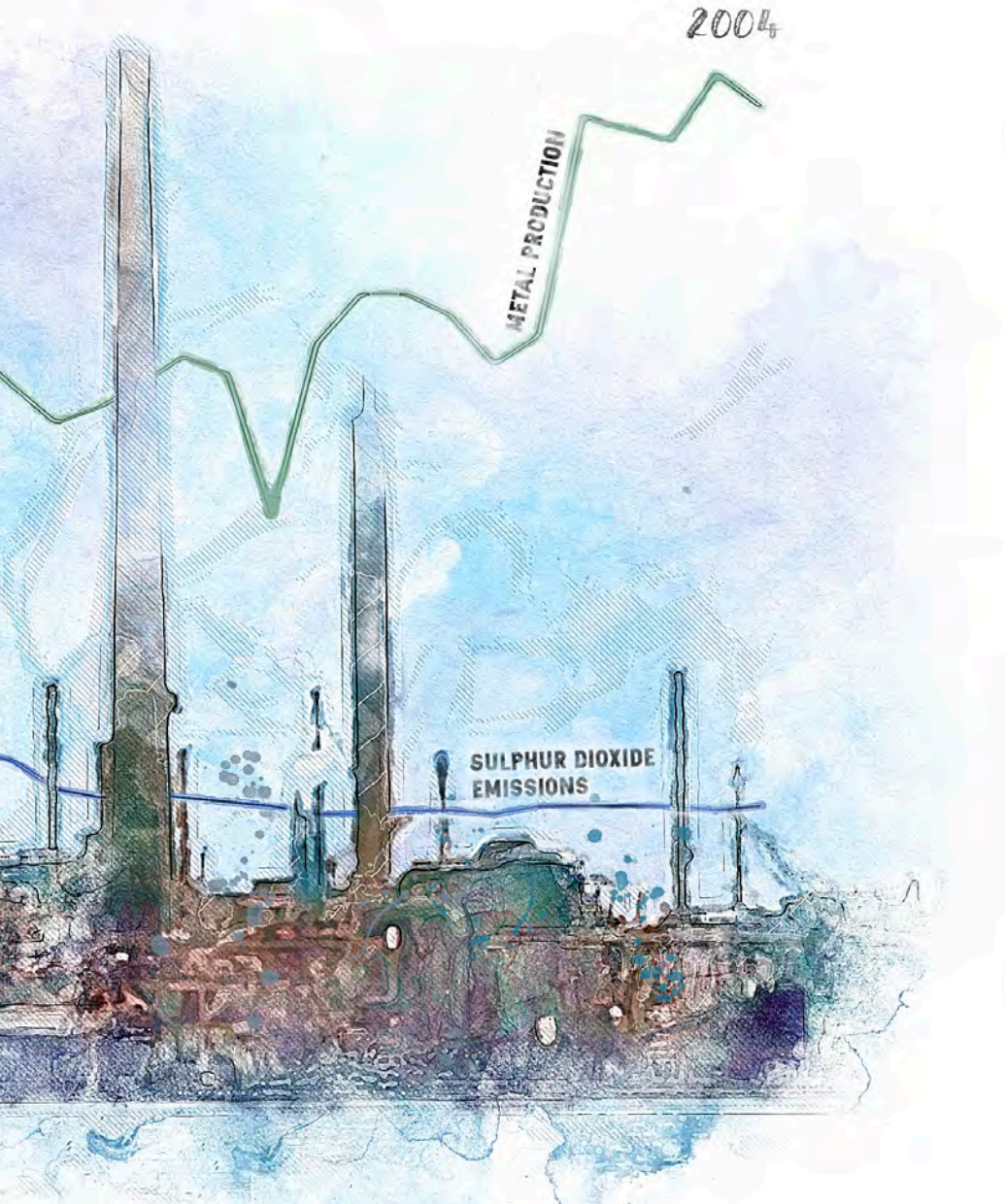
THE RISK of becoming less competitive and encountering reduced economic growth are usually strong arguments against investing in far-reaching measures that will improve our climate and the environment. So why exactly has Sweden succeeded?

Let's go back a few decades. As pollution problems generally became more perceptible in the mid-20th century, environmental issues came to the fore. In Sweden, trade and industry had premonitions of stricter legislation that couldn't be circumvented – the new Environmental Protection Act came into force in 1969. That was why industry initiated a research institute, IVL (now IVL Swedish Environmental Research Institute), in 1966 to work with the environment and sustainability. Its objective was to coordinate development of technology between the government and trade and industry in order to create an understanding of the environmental impact of emissions, and to devise technical solutions to a number of acute problems.

This cooperation, along with the fact that industry took the problems seriously at an early stage, is one of the major reasons as to why transitions in Swedish industry driven by the environment have been successful from an international perspective, according to Ann-Kristin Bergquist. The fact that the government, for its part, took into account the economic frameworks of trade and industry, but also its engineering skills, is another factor in this success.

"Companies were given a great deal of freedom to develop new technology. This stimulated technical development and reinforced competitiveness in the long term.

Swedish environmental policy has had a global status since the 1970s, although there are still challenges to be faced here.



In the 1960s, the Rönnskärsverken smelters in Skellefteå municipality was the dirtiest industry in Sweden. But as they transitioned, emissions reduced and, remarkably, production thrived.

What could a country like China learn from Sweden?

"To set long-term targets for environmental policy, strict but flexible targets, and maintain stability over time despite new political flows," says Ann-Kristin Bergquist, who admits that applying Swedish environmental legislation and instruments to other countries isn't entirely straightforward.

"This is because policies are always based on the institutions that you have in society, and they've developed over a very long time. Sweden has a fairly high level of institutional efficiency based on cooperation, compromise and low corruption, in a small country with fairly homogeneous values. The Swedish economy is also very small compared with countries like China and the US."

Despite this, it's important for Sweden to lead the way – for a number of reasons.

"Sweden is important when it comes to driving innovation and technical development. We have good institutional conditions here."

ANN-KRISTIN BERGQUIST is now looking at climate transition from an international perspective in order to identify the current obstacles.

"To be honest, unfortunately, this has made me less hopeful."

In the late 1980s, leading western countries – with the US in the lead – came close to an agreement on regulating carbon dioxide emissions. But then things changed, and suddenly people believed that the market would resolve the problems – and this mindset is still in evidence now.

"What people have missed in these visions and hopes is that the problems are at system level. Individual companies have very little opportunity to do anything radical, because they'll find it difficult to compete unless other companies follow their lead."

NOWADAYS, FOSSIL fuels still account for more than 80 per cent of global energy consumption. In the short term, countries are extremely dependent on fossil energy to maintain their standard of living, and to increase it in low-income countries. But the climate is paying a high price for this.

Ann-Kristin Bergquist is of the opinion that the climate transition requires global agreements that include higher prices for fossil fuels, combined with funding for renewable energy.

"It's extremely important to have a collective global policy that brings pressure to bear in order to increase the pace of progress. That's probably the biggest conclusion we can draw, if we look back over the years. But that also presents us with our greatest challenge."

That said, she believes in consumer power and movement from below as influencing methods.

"What this new generation, like Greta Thunberg, represents is really important. We need something similar to what happened in the 1960s, which was truly formative. This is a new awakening, and I believe it's truly important if we're going to bring interests to the negotiating table." ✖

By 2050, more than ten million people a year worldwide are expected to die as a result of drug-resistant diseases.

FINDING NEW METHODS ... AND NEW MOLECULES

Antibiotic resistance is one of the biggest threats to human life on Earth. Chemist Fredrik Almqvist is seeking solutions, but concludes that focusing on finding classic new antibiotics won't be enough. It will take too long.

Text: **Inger Nilsson** Photo: **TEDxUmeå and Mattias Pettersson**

According to Fredrik Almqvist, we need to use all methods available in the fight against drug resistant bacteria.

"We have to help existing antibiotics gain momentum. For example, researchers are studying how the immune system can be stimulated, or the use of 'targeted' viruses, special viruses/bacteriophages that knock out a certain kind of bacteria."

He has spent a lot of time finding new ways of disarming bacteria.

"Finding a new molecule is a fantastic feeling. Chemists love creating new molecules, molecules that don't exist."

But now it's urgent. People can die from sepsis – poisoned blood caused by killer bacteria – within a few hours. Chlamydia, which is treated in 140 million people every year, isn't deadly, but it has to be treated and vast quantities of antibiotics are consumed every day on account of this.

"Because of antibiotic resistance, there's a risk that people will start dying younger again."

Health care services can reduce their use of antibiotics. Sweden – and Västerbotten – has fared comparatively well in this regard, but antibiotic resistance is a global problem.

"As private individuals, we have to first and foremost be careful when it comes to hygiene. Everyone who has the opportunity to choose foods produced without antibiotics should do just that. Food production accounts for around 70 per cent of antibiotic use, and this figure has to be reduced."

Fredrik Almqvist points out what happened when the swine flu was rampant.

"Disinfectant was used all over the place, and as a result people took less time off work to tend to their sick children."

When pharmaceutical companies stopped investing in development of new antibiotics – when it became too expensive to do this, and they couldn't earn money – things became difficult for researchers. Both time and money are needed – and more chemists as well – if we are to combat antibiotic resistance.

Fredrik Almqvist

"I'm an optimist, but we have to be prepared to pay for that development. We researchers need to work together. If we know there's the slightest little chance of saving lives, we have to carry on doing what we're doing." ✖

UNDERGROUND THREAT TO OUR NATIONAL PARKS

Earthworms have been viewed as useful creatures in Sweden for a long time, acting as a driving force behind a sustainable cycle. In other parts of the world, their reputation isn't quite as good. Soil researcher Jonatan Klaminder reckons it's time to question our attitudes towards these underground diggers — at least when it comes to unused land with high biodiversity.

Text: **Camilla Bergvall** Illustration and photo: **Mattias Pettersson**

The instinct to save earthworms fleeing from rain-soaked land is deeply ingrained in many of us. Jonatan Klaminder, Associate Professor at the Department of Ecology and Environmental Science, has also been very positive about these little creatures for a long time – they eat and break down dead plants and oxygenate and drain soil as they move around. It's only in the last few years he's had to think again.

Jonatan Klaminder

"Entire ecosystems are affected when earthworms spread to forests that have been worm-free for thousands of years. Apart from the fact that the structure of the earth changes, the worms drag down that top layer of dead plant parts – the humus layer. This eliminates vital protection from the cold and seed-eating animals that some mountain plants depend on in order to survive," he says and continues.

"In North America, they've introduced restrictions to actively protect their national parks from European worm species. But in our major mountain parks – such as Padjelanta, Sarek and Abisko – there are no restrictions on bringing in earthworms. The question is, should we restrict this? According to him, it's extremely difficult to eradicate earthworms once they've established themselves in currently worm-free areas," he says.

JONATAN KLAMINDER is currently heading a study to identify the extent to which various earthworm species have managed to propagate in the Swedish mountains, and what effects they're having on the mountain environment.

"We now know that worms spread from agricultural land, lawns and garden composts in the mountains. Among others, we've found those plump, pale terrors that alter the soil most, according to American studies. But the question now is how are these species affecting our mountain birch forests. Is this something to be concerned about?"

IT'S ALARMING to note that American studies have proven that the presence of earthworms may be behind cascade effects in ecosystems. In other words, when certain plant species disappear, numbers of grazing mammals also decline. It's also worrying to note that worm activity can benefit invasive plant species. But perhaps most terrifying of all, today's climate models may have to be reworked.

"We're concerned that the ability of earthworms to accelerate decomposition may affect soil carbon emissions just as much as future climate change in the areas in which they establish themselves. Backed up by the precautionary principle, I'd like to encourage all fishermen – until further notice, at least – to stop releasing their leftover worms into the wild in the mountains. In fact, this is something that I personally have been doing for many years," says Jonatan Klaminder. ✖

Spread of earthworms
There are currently around 2,000 earthworm species in the world, of which 14 are found in Sweden. Earthworms spread naturally at a rate of 5–15 m/year. Without the help of farmers, and then fishermen as well, they'd have only made it as far as Denmark after the ice age. When earthworms arrived in Sweden and the mountains has not been clarified.

Advantages of mixed forests
According to researchers, mixed forests are less susceptible to fires, droughts, storms and insects than forests accommodating a single tree species — known as monoculture — and are also much better at supplying more ecosystem services.

MIXED FORESTS ARE THE FUTURE

Properly mixed forests are more valuable than the monoculture that dominates at present. This is demonstrated by Micael Jonsson, an ecologist at Umeå University, in his research.

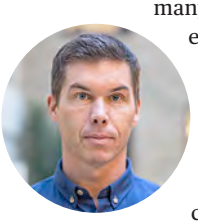
"The switch has to start now. What we do with our forests today is something we'll have to live with for at least 70 or 80 years," he says.

Text: **Nils Fredriksson**
Photo: **Ulrika Bergfors and Mostphotos**

In early 2019, Micael Jonsson published an article about mixed forests in Nature Plants, together with Jan Bengtsson and Tord Snäll at the Swedish University of Agricultural Sciences, Lars Gamfeldt at the University of Gothenburg and Jon Moen at Umeå University.

The article presents a study on which tree types should be mixed in order to improve tree growth and promote biodiversity. By analysing data from the National Forest Inventory, the researchers show that it's important to mix the right tree types. Spruce and birch is best in the north, while fir and birch promotes more ecosystem services in southern Sweden.

THIS ARTICLE is a follow-up to an article that Micael Jonsson helped to publish in Nature Communications in 2013, which criticised monoculture in Swedish forestry.



Micael Jonsson

"The major forestry companies' clearing of forests devastates biodiversity and many other services provided by forests," says Micael Jonsson.

MANY BENEFITS would be achieved if the forest industry was to follow the advice provided by Micael Jonsson and his colleagues. Mixed forests are less susceptible to fires, storms, droughts and insects than monocultures. Mixed forests can also improve timber quality and the forest can be used for products with longer service life.

"Fast-growing spruce forests are often turned into short-lived products such as paper, which gives rise to immediate carbon emissions in the atmosphere. Forests bind more carbon if we allow them to get older, which is beneficial for our climate," explains Micael Jonsson.

Another aspect is that nobody knows what the most attractive features of forests will be in a hundred years' time. If

tourism, for example, is the main reason why people visit forests, clearing forests and spruce monocultures won't be what people want to go and see.

MICAEL JONSSON is seeing positive signs right now. Clearing forests is criticised more frequently, the Swedish Forest Agency is providing information about mixed forests, many private forest owners in southern Sweden want to fell fewer trees, the number of women owning forests is increasing, and these women are more inclined to prioritise forest assets other than timber production. But he thinks decisions are needed from on high in order to accelerate this development.

"Switching to more mixed forests is a major, and probably costly transition for the forest industry to make, and it's not straightforward from a political perspective as jobs may be lost in the short term. But in the longer term, more mixed forests would increase the sustainability of forestry by promoting all forest assets." ×

The 2030 Agenda – for a sustainable future

The 2030 Agenda is the most ambitious agreement ever adopted for sustainable development. The concept integrates the three dimensions of sustainability: social, economic and environmental. With this agenda, world leaders have undertaken to deal with three crucial global challenges by 2030: to eradicate extreme poverty, combat inequality and injustice, and resolve the climate crisis.

Sustainable development requires joint action on a global, national, regional and local level. The agenda underlines the link between different levels, as well as the importance of partnership between governments, the business community, the academic community and civil society.

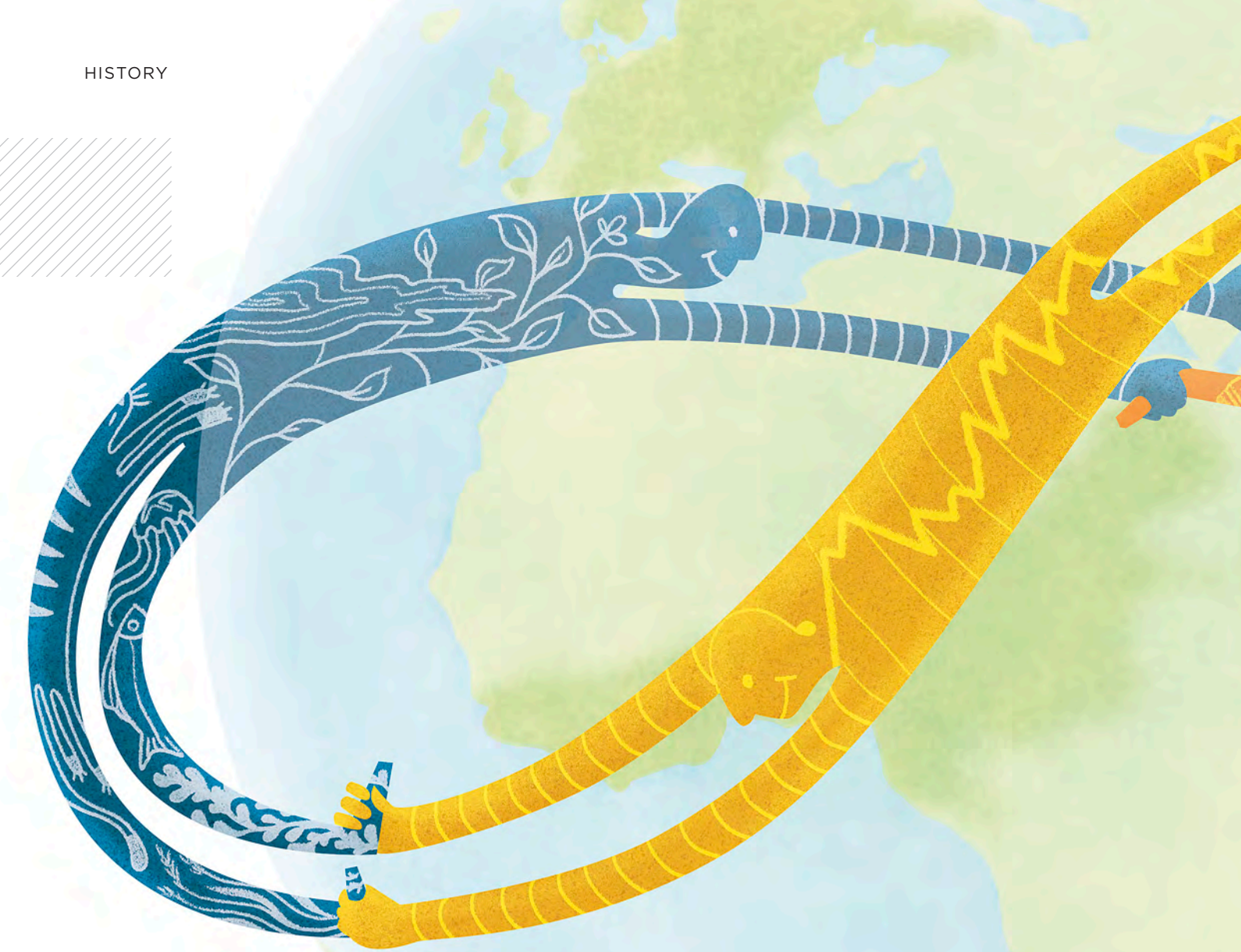
The county administrative boards represent the government at a regional level and have assignments and activities in most policy fields. All 17 targets in the agenda affect the operations of the county administrative boards. This is why the county administrative boards have been assigned a key role in the implementation of the 2030 Agenda. The appropriation directions indicate that the county administrative boards, in cooperation with other relevant county stakeholders, must take action to achieve these targets and distribute information about their work.

'TOGETHER, WE make the sustainable possible' is the mission statement for the Västerbotten County Administrative Board. We're working together to develop communities and rural areas where the environment, growth and good living conditions all go hand in hand. As part of our agenda work for 2020, we're planning in particular to focus on areas such as protecting our cultural heritage, implementing disaster risk reduction strategies, eradicating invasive species, promoting sustainable use of ecosystems on land and in freshwater, promoting a reduction in food wastage, promoting sustainable forestry and contributing to development of rural regions. One close, important partner in this regard is Umeå University, which is providing high quality research and education with breadth.

GLOBAL DEVELOPMENT is moving in both a positive and a negative direction. The challenges that the world faces require action that will lead to change. True change can be achieved when the desire is there and when countries agree. ×

LARS LUSTIG
County Director at the Västerbotten County Administrative Board and Vice Chairman of the University Board, Umeå University

Photo: Mattias Pettersson



THE BIRTH OF SUSTAINABLE DEVELOPMENT

In the early 1980s, the United Nations appointed an environmental commission made up of politicians and experts. The final report entitled “Our common future” was crucial to opinions on sustainable development as an issue with an ecological, a social and an economic dimension.

Text: **Ulf Holmgren**
Illustration: **Felicia Fortes**

In the mid-1980s, Gro Harlem Brundtland – then Prime Minister of Norway – was tasked with heading a strategic group within the UN system. Her job was to devise a proposal for long-term global environmental strategies. The final report was published in 1987 and was entitled 'Report of the World Commission of Environment and Development: Our Common Future'. This report accommodates a broad overview of many of the issues that were and continue to be crucial to the future of mankind. The report includes chapters on economic issues, population issues, food supply, biodiversity, urbanisation, industrial issues and – not least – how humanity should manage common resources.

IT ALSO includes the generally accepted definition of sustainable development: "Sustainable development seeks to meet the needs and aspirations of the present without compromising the ability to meet those of the future". Immediately after this definition is a two-point supplement. The first point emphasises that in the first instance, the needs of the poor of the world must be met. The second point relates to the fact that technical and social systems must harmonise with a good environment.

Brundtland's definition of sustainable development has had a major impact thanks to its straightforward comprehensibility. The basic concept is that it's all about living a good life, and that the generations that come after us must also be able to live good lives. Who wouldn't go along with that?

But there are two problems with the wording. The first is the term 'needs', which means completely different things to different people, in different contexts and different situations. The authors of the report tried to fend off this problem in the supplement to the original document. The second problem is the word 'development'. This may allude to societal development in the sense of 'switching to a sustainable society'. But it can also be interpreted as economic development, measured in terms of traditional economic growth.

There is much to indicate that the Brundtland Commission perceived no actual conflict between these approaches. Under the heading 'Changing the quality of growth', the document states:

"Sustainable development involves more than growth. It requires a change in the content of growth, to make it less material- and energy-intensive and more equitable in its impact. These changes are required (...) to maintain the stock of ecological capital, to improve the distribution of income, and to reduce the degree of vulnerability to economic crises."

The Commission is of the opinion that economic growth is necessary in order to improve the situation of the poor, but the intention is also to link growth with development that is ecologically acceptable and socially sustainable.

One approach from the Brundtland Report that has proven to be particularly useful is the division of sustainability into an ecological, a social and an economic dimension.

ECOLOGICAL SUSTAINABILITY is all about living within the bounds of the ecosystems – maintaining the viability of ecosystems, economising on resources and limiting the impact of emissions.

A socially sustainable community is fair, equitable, inclusive and democratic. It guarantees a reasonable quality of life for present and future generations.

A sustainable economic system, finally, is predictable and legally secure. Reasonably, it should also help to fulfil the Brundtland Report's desires to maintain ecological capital, even out economic injustices and reduce the vulnerability of the system.

However, humanity has not been particularly successful in respect of any of these three dimensions. We exceed our planet's limits in terms of biodiversity and pollution. We need to reduce global greenhouse gas emissions by 10-15 per cent per year in order to meet our climate targets. As regards social sustainability, two billion people live on less than three dollars per day. There is also plenty of progress to be made as regards economic sustainability.

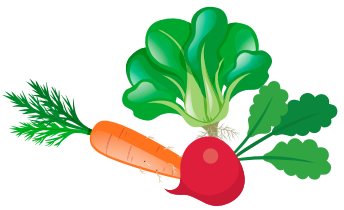
Prior to the new decade, many people have talked about the green transition and green growth. This transition needs to be handled as a matter of urgency, given the seriousness of the situation. But at the same time, changes motivated by the green transition – such as the increased need for metals for batteries, solar cells and generators, for example – need to be made in a way that respects both nature and culture. ✖

Ulf Holmgren is an associate professor and certified engineer. Together with Håkan Gullikkson, he wrote the book "Hållbar utveckling: teknik, samhälle och livskvalitet". The third, updated edition of this book was published in 2018.

SO MUCH MORE EDIBLE FOOD CAN BE SAVED

The gastronomy programme is working together with a waste company to change behaviours and reduce food wastage.

Text: **Jonas Lidström** Photo: **Patrick Trägårdh** Illustrations: **Freepik.com**



Food wastage is a problem that can be seen from the things we throw out. According to the latest figures from the Swedish Environmental Protection Agency (2016), Swedes threw away 200,000 tonnes of edible food in a year.

But to reduce food wastage, we need to stop looking at mountains of rubbish and instead consider how we buy ingredients and plan and cook our meals.

WITH THIS in mind, it is fairly logical for Umeå's municipal water and waste company Vakin and the gastronomy programme at Umeå University to start working together under the slogan Rädda maten – Save our Food.

AT THE last popular Umeå Taste Festival, gastronomy students presented a demonstration kitchen at the Town Hall Square and cooked small portions of delicious meals based on ingredients that are frequently thrown away.

"Our tasting menu included pesto made from vegetable tops and leftover legumes, toasted sandwiches and bread pudding," explains Björn Norén, lecturer at the Gastronomy Programme.

This partnership has also resulted in an inspiring knowledge base for cooks who want to avoid throwing food away. Rather than creating a cookbook with set recipes, their information is made up of 'idea cards' that provide a general view of options for using various ingredients. ×

Recipe/idea bank
This information bank is available in a digital format at vakin.se/kampanjsidor/raddamaten. Take a look there next time you clear out your fridge or pantry. Dry bread, lettuce that has past its best and forgotten root vegetables offer more options than you think.

Our conscience helps us change

Annika Nordlund is docent in environmental psychology at Umeå University. She reckons that having a bad conscience may help to prompt more climate-friendly behaviour.

"If we can create internal motivation for action, we can put up with the sacrifices we'll have to make as a result."

At the same time, it's important to have the tools and knowledge that will allow people to do the right thing.

"In a worst-case scenario, scaring people might lead to apathy – and that's not what we want."

Annika Nordlund believes it's important for us to take action as individuals, even if we just make little changes to the packaging we choose, or skip a few trips in the car. Because of the climate crisis, we all have to think along new lines.

"We've created this problem together, and we all have to resolve it together."

A longer report about Annika Nordlund can be found at umu.se

Annika Nordlund

VEGETARIAN LUNCH NO BIG DEAL FOR CHILDREN

When a municipal pre-school in Umeå decided to introduce a fully vegetarian menu for climate reasons, this was a big news item both locally, nationally and on social media.

Some critics questioned the balance and nutrition of a vegetarian diet.

Agneta Hörnell, professor of food and nutrition at Umeå University, answered some of the queries about lunch in an interview in Swedish radio.

"A fully vegetable-based lunch isn't an issue. What matters is instead to plan it well."

Agneta Hörnell

In the latest revision of the Nordic Nutrition Recommendations, Agneta Hörnell led the team of experts that were responsible for the recommendations for infants, children and young adults.

The recommendations can be found on the Swedish Food Agency's web site for anyone who would like science-based guidelines to nutritious food.

SENSUALITY IN DESIGN

Interior design blogger Frida Ramstedt believes we will stop consuming interior design with our eyes in the 2020s. The industry needs to reduce the use of unsustainable materials such as chipboards and plastic.

Do you think Swedes will adopt a more sustainable approach to using interiors over the next few years?
"The concept 'the next few years' is a very short time. We probably shouldn't expect this industry to undergo a major transition in just a few years. But I've seen consumers become more aware of and interested in environmental and sustainability issues over the past few years."

What needs to change?
"Materials to a certain degree. We know plastic bags are bad and make a mess of our environment. But sofas stuffed with resilient foam contain a lot more plastic, made from fossil raw materials such as oil and natural gas. All furniture made from fibreboard is another example. They have short service lives and are burnt up in the end."

Are natural materials a solution?
"Furniture made from natural materials such as solid wood have a whole different service life and can be repaired. But to use furniture sustainably, we also have to take a much more long-term approach to the things we buy. If you renovate your kitchen as soon as it starts to feel a bit outdated, that's unsustainable even if your new cupboard doors are made from recycled corn fibres."

How can we break this pattern?
"When I hold lectures, I usually talk about what I call 'visualism' – the fact that for a long time now, we've consumed interiors with our eyes. Advertising, interiors magazines and blogs have played an important part in this emphasis on the visual, with shifting trends and styles. But I very much believe we're starting to focus more on function now, while also becoming more sensual and tactile. From visualism to sensualism! ✖

FUTURE PEOPLE IN OUR HANDS

The definition of sustainability takes future people into consideration. But who and how many are they? These are questions Kalle Grill wants to answer.

Text: **Johanna Fredriksson**
Photo: **Mattias Pettersson**

Sustainable development is development that satisfies existing needs without endangering the possibilities for future generations to satisfy their needs.

That sentence comes from the Brundtland Report written by the World Commission on Environment and Development for the UN in 1987. It was this report that gave sustainable development international attention and became a leading concept.

But what does 'future people' mean in this context? Who and how many are they? How do present-day humans affect future generations?

Kalle Grill, docent in philosophy at Umeå University, is studying these questions in-depth in a four-year research project.

"I'd like to better understand and come to terms with what 'future generations' means in terms of sustainability," he says.

KALLE GRILL suggests that the concept of sustainability in its current use is unprecise, and that it contains a presumption that there will be humans in the future, something that is not set in stone.

According to him, we can determine how many people will be around in the future. We know that policy calls, such as subsidies for child care, affect if people have children, and how many. From a sustainable perspective, several scenarios can be regarded as sustainable.

"Should we aim for fewer people with a high standard of living, or is it alright if a larger number is born with lesser opportunities, fewer travels and a lower standard of living?"

Using research, we can affect how humanity develops.

"Through gene-technology or by replacing future humans with artificial intelligence, maybe we could get people to settle for less, with reduced needs. Either physically or psychologically. If they settle for less, we can use up more resources now. Is that sustainable?" Kalle Grill wonders and says that thinking along those lines agrees with the literal definition, but the authors probably didn't intend just that.

The purpose of his project is to define what is meant by 'future people' in the sustainability definition, make it well-defined and hence more useful as a policy tool.

"We're making sure that 'future generations' means the right thing. ✖

Kalle Grill is docent and associate professor of philosophy and coordinator of the Bachelor's programme in Philosophy and Social Analysis. He teaches and supervises moral and political philosophy.

He runs several research projects, one of them being "Future people and the sustainability concept" together with Lars Samuelsson. The project finishes in 2020.

Mosquitoes spread Zika virus in Europe

Zika is a disease that often only results in mild symptoms, but it can also cause abnormal brain development (microcephaly) in foetuses if a woman catches it. At the end of 2019, the first people got Zika by a virus transferred by mosquitoes in Europe. In all previous cases, Europeans have either been contaminated on travels in Zika-affected countries or through contact with other contaminated people. Umeå University coordinates the project ZikaPLAN, Zika Preparedness Latin American Network, gathering 25 leading research and public health organisations to build up preparedness for Zika outbreaks. One of the Umeå researchers is Joacim Rocklöv.

Joacim Rocklöv

"I'm surprised that the disease is starting to spread by mosquitoes in Europe right now, since not many cases have been reported across the globe since the South America outbreak in 2016–2017. Maybe these cases are due to the mosquitoes increased ability to spread the virus in higher temperatures," he says.

Photo: Mattias Pettersson

Curiosum opens its doors

Umeå University's new science centre and maker space, Curiosum, will be ready to open at the Umeå Arts Campus in 2020. Children and adults can explore and be inspired by science and technology here. Visitors to the planetarium will be able to go on interactive journeys into space, and films and presentations will be shown on a domed film screen, providing new perspectives on our world.

Photo: White arkitekter

STUDIES HOW AI CAN HELP STRESS

How do people react to an AI-based social companion, or assistant, when dealing with stress-related illness or fatigue?

Helena Lindgren, Professor at the Department of Computing Science, studies this phenomenon. She is one of 16 researchers at various Swedish universities who share SEK 96 million from the Wallenberg Foundations, which is investing a total of SEK 660 million over ten years on social and humanities aspects of AI and autonomous systems within the new research programme WASP-HS. Umeå University is in charge of the programme.

The University Board has also decided to invest SEK 100 million over ten years on AI research.

Photo: Mattias Pettersson

Top ranking at just over 30 years old

For the fourth year in a row, the Umeå Institute of Design has taken first place in the Red Dot Design Ranking, which ranks design training courses in Europe, North America and South America.

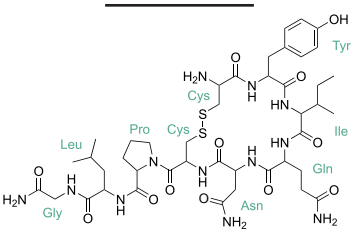
"Yet another first place for us shows that we're still at the cutting edge despite incredible global competition," says Professor Thomas Olofsson.

The Umeå Institute of Design opened in 1989 and has just celebrated its 30th anniversary.

Photo: Peder Fällefors

Tourism and natural resource exploitation no opposites

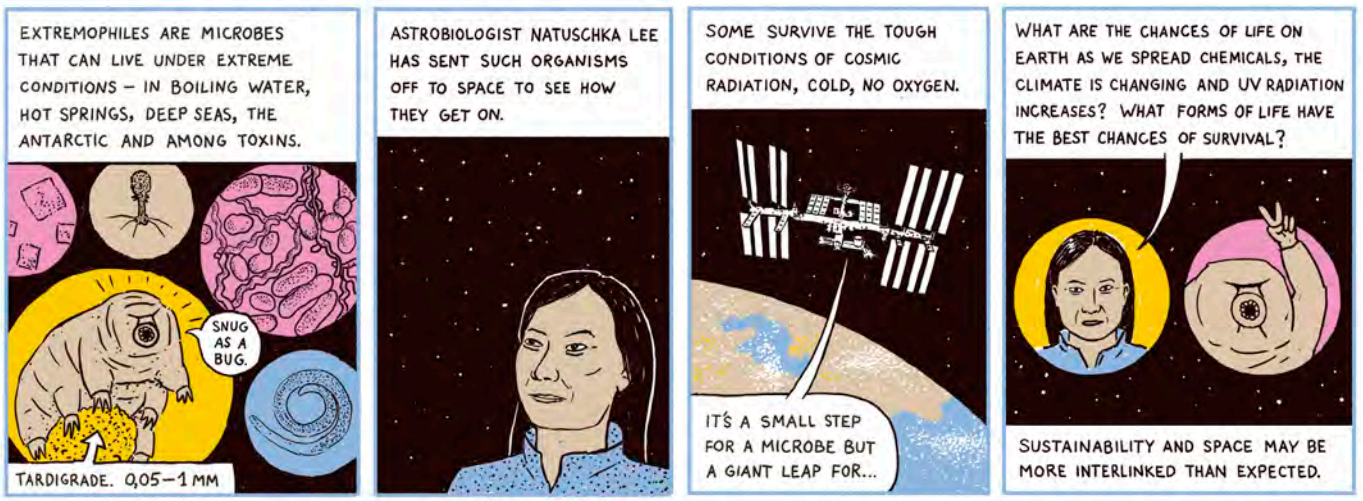
New human geography research has found that establishment of mines, development of hydropower and forestry often fund the infrastructure required by tourism in northern Sweden.



Oxytocin and sex addiction linked

The hormone oxytocin may be linked with hypersexual disorder, often known as sex addiction. This new discovery is paving the way for new potential therapies.

Illustration: Wikipedia/Cavero



SUSTAINABLE LIFE ON EARTH AND IN THE UNIVERSE

When we consider what things will be like for future generations, we often consider a life on Earth. Microbiologist and astrobiologist Natuschka Lee is trying to understand the origins of life and our opportunities for survival and development – on our planet or elsewhere.

Text: **Camilla Bergvall** Illustration: **Kalle Johansson** Photo: **Mattias Pettersson**

Even as a child, Natuschka Lee was fascinated by how life came about on Earth, and whether there's life out in space. Who are we? Where do we come from? What's our place in the universe?

"I believe these are existential questions that everyone is actually interested in, whether you're religious or an atheist."

As a microbiologist and astrobiologist, she researches extremophiles, microorganisms that are able to withstand harsh environments.

Natuschka Lee

They live in really odd ecosystems all over the world, even underground, but they can also live in regular organisms where there's no oxygen, such as in our own gut flora.

"Extremophiles are interesting to study because they can develop in environments that are reminiscent of what things used to be like on Earth – before there was oxygen in the air, for example. Similar organisms could exist on at least some other cosmic bodies, such as Mars or some of the moons of Jupiter or Saturn."

READ MORE

Take a look at umu.se to find out more about research in progress at Umeå University.

UMEÅ UNIVERSITY