Your respective areas of expertise centre on various aspects of air pollution, but what are your major overarching goals?

The air quality that impacts human health and ecosystems in Nordic countries depends to a large extent on the long-range transport of polluted air from continental and Eastern Europe, as well as from across the entire Northern Hemisphere. In order to abate these significant air pollution problems, it is vital to keep track of the sources of different air pollution episodes. In our work, our primary aim is to monitor and assess these episodes and prevent air pollution from exceeding critical levels in Nordic countries.

You have examined the consequences of large-scale biomass burning in Eastern Europe, especially in southern Russia. Can you provide a context for these burnings, explaining why they occur and how long they have been happening?

Agricultural burning is mainly used as a method of clearing land from agricultural waste – such as clearing fields from crop residue – in order to prepare them for new planting. Unfortunately, it is a major fire hazard; there is always a danger that the blaze will get out of control and spread to adjacent forests, grasslands or peatlands. Other concerns include the fact that agricultural burning is a major contributor to levels of black carbon in the Earth’s atmosphere and that human-made fires are a significant source of air pollution. Because our expertise mainly centres on air pollution monitoring and impact assessments, we are actively seeking to forge connections with experts on large-scale biomass burning in Eastern Europe. Essentially, this an area that we must work on together. Collaboration is critical.

What are the major health and environmental issues that these burnings present?

The major health issue is increased concentrations of particulate matter and trace gases released as a result of burning, which affect air quality across the Nordic countries. Moreover, polluted air from Eastern European countries in episodes, such as the one that occurred in May 2006, can result in the groundlevel ozone concentrations exceeding the EU information threshold of 180 µg/m³ – another factor that negatively impacts health. As for the ecosystem, a key issue is the unusually high groundlevel ozone concentrations in the northern part of the Nordic countries, including Iceland. Unfortunately, this is known to have a negative impact on vegetation. Furthermore, the pollution episode in spring 2006 resulted in the deposition of nitrogen to forests in mid- and northern Sweden – around 1 kg N/ha/month – which is highly significant in relation to the nitrogen critical load for mountain area forests adopted by Sweden of 3 kg N/ha/year.

Though these biomass burnings occur in Eastern Europe, they impact neighbouring countries. What scientific evidence have you gathered to attribute effects in other countries to these agricultural fires?

This evidence comes from analyses of trajectories – that is, the airmass movements over time – combined with temporal measurements of air quality deterioration and deposition to forests at different sites.
Air pollutants from Eastern European biomass burning

Researchers from four institutions – the IVL Swedish Environmental Research Institute, the Norwegian Meteorological Institute, the Norwegian Institute for Nature Research and Norwegian environmental organisation the Bellona Foundation – are exploring the link between large-scale biomass burning in Eastern Europe and intensified air pollution in the Nordic countries.

AGRICULTURAL BURNING IS a common practice in many areas of Eastern Europe. Employed by farmers to clear crop residue from fields or reeds from the beds of drained reservoirs, this method is effective; however, it is implicated with serious health and environmental concerns. For instance, for residents in nearby areas, the burning season – which extends from early summer to late autumn – is synonymous with unclean air, poisoned with fumes from the smoke. In some local areas, the skies become clouded with smog and soot, while thick ash settles on homes and gardens.

In addition to the detrimental effects of large-scale biomass burning on health and the environment in Eastern Europe, the long-range transport of polluted air also triggers severe pollution problems elsewhere, such as in the Nordic countries: “Emissions from this large-scale agricultural burning represent an important component of the Northern Hemispheric air pollution,” points out Professor Per Erik Karlsson, Senior Scientist from the IVL Swedish Environmental Research Institute. “During the last decade, several large-scale biomass burning events in Eastern Europe – particularly in southern Russia – have had severe consequences for human health and the ecosystems.” Indeed, recent advances in remote sensing technology have led to more detailed assessments of the consequences of annual fires in the Russian forests and agricultural land.

INTERESTED IN AIR POLLUTION AND BIOMASS BURNING?


Karlsson, P E; Ferm, M; Tømmervik, H; Hole, L R; Pihl Karlsson, G; Ruoho-Airola, T; Aas, W; Hellsten, S; Akselsson, C; Nærgaard Mikkelsen, T; Nihlgård, B, 2013, Biomass burning in Eastern Europe during spring 2006 caused high deposition of ammonium in northern Fennoscandia, Environmental Pollution, 176: 71-79

PINPOINTING THE PROBLEM

One of the most extreme biomass burning events occurred in May 2006, after which highly polluted air from Eastern Europe dispersed towards the northwest, extending across Northern Europe from Scotland to Finland and Iceland to Svalbard. Consequently, high concentrations of particulate matter were measured in Edinburgh, Stockholm and southern Finland, while high concentrations of groundlevel ozone were documented in Sweden and Iceland – in Sweden these concentrations exceeded the EU-recommended threshold levels. In addition, high concentrations of black carbon were reported in Swedish air and high nitrogen deposition was measured to forests in mid-Sweden, as well as to trees in the alpine regions of its mountain range. Unusual visible injuries/discolourings on the leaves of birch and rowan trees in northern Fennoscandia were observed during the same spring and summer. Snow on a glacier in Spitsbergen, Norway, was even discoloured.

As a result of these extreme adverse effects of biomass burning in Eastern Europe, with funding from The Nordic Council of Ministers, scientists based in the Nordic countries increased their efforts to investigate the origins and aggravators of air pollution at northern latitudes. Karlsson is working in close collaboration with Drs Lars Robert Hole and Hans Tømmervik, as well as Elena Kobets, Program Director at the St Petersburg office of the Bellona Foundation, an independent non-profit organisation that aims to meet and fight the climate challenges, through identifying and implementing sustainable environmental solutions. Their primary objective with these efforts is to prevent air pollution in Nordic countries from exceeding critical levels, to prevent impacts on human health and ecosystems. To achieve this, they are attempting to build a fuller understanding of how airflow trajectories correlate with atmospheric pollution and deposition in forests along the polluted airmass pathway over time.

BREAKING THROUGH BORDERS

Indeed, biomass burning is one of the common forms of transboundary pollution – a form of pollution that refers to the dispersion of airborne contaminants across geopolitical boundaries or even across entire hemispheres. Unfortunately, although local air pollution events can to some extent be mitigated by strict policy controls, it is extremely difficult to address transboundary pollution as it often lingers in airflows for extended periods of time. For example, common pollutants such as fine particulate matter, black carbon and ozone gas precursors have lifetimes of several days – or, in the case of stagnant atmospheric conditions, weeks – meaning that they can easily be transported for several thousands of kilometres. Moreover, the situation becomes even more complex in cases where the

WWWINTERNATIONALINNOVATIONCOM 77
INTELLIGENCE

BIOMASS BURNING AND CONSEQUENCES ON AIR QUALITY IN NORDIC COUNTRIES

OBJECTIVES
• To investigate how the long-range transport of polluted air from large-scale biomass burning causes substantial air pollution problems and ecosystem impacts in the Nordic countries
• To analyse how the negative consequences of large-scale biomass burning in Eastern Europe can be mitigated

KEY COLLABORATORS
IVL Swedish Environmental Research Institute • Norwegian Meteorological Institute • Norwegian Institute for Nature Research

PARTNERS
Bellona Foundation, Norway

FUNDING
The Nordic Council of Ministers – Climate and Air Pollution Group (Kol) • Internal funding from the involved institutes • The Ministry of Environment of Sweden

CONTACT
Dr Lars Robert Hole
Norwegian Meteorological Institute
Henrik Mohns Plass 1
0313 Oslo
Norway
T +47 552 366 25
E lrh@met.no

PER ERIK KARLSSON is Senior Scientist at the IVL Swedish Environmental Research Institute and Professor in Plant Physiology and Air Pollution Impacts on Plants at the University of Gothenburg. He is developing critical loads and levels to protect vegetation against air pollution damage in Europe.

LARS ROBERT HOLE is a senior scientist at the Norwegian Meteorological Institute. His research focuses on the applications of micro-meteorological measurements, climate change effects, atmospheric transport and deposition of pollutants, marine meteorology and oil drift modelling.

HANS TØMMERVIK is a senior scientist at the Norwegian Institute for Nature Research (NINA), working within the High North Research Centre for Climate and the Environment. His current interests involve vegetation ecology, ecophysiology, applications of remote sensing, vegetation mapping and monitoring, air pollution and climate change effects on vegetation.

ELENA KOBETS works at the Bellona Foundation and leads a project involving the impact of short-lived climate forces on the Arctic. For the last 15 years, Kobets has worked with Russian and international NGOs in the spheres of environmental protection.

source of transboundary pollution is a country where emissions are unregulated.

It was back in the 1970s that scientists realised that the long-range transportation and deposition of acidifying and eutrophying pollutants were vital factors in air quality and ecosystem health. As a result, the Convention on Long-Range Transboundary Air Pollution was formed in 1979, shining the spotlight on the long-range transportation of pollutants for the first time. Since then, numerous studies have mapped the origins and effects of transboundary pollution, and demonstrated that exposure to particulate matter and ozone can lead to reduced life expectancy from pulmonary and cardiovascular diseases.

Indeed, over the course of the past decade, multiple studies have analysed the human health impacts of the long-range transportation of air pollution from areas in Eastern Europe to the Nordic countries. For instance, it has been well-established that human exposure to particulate matter and black carbon is damaging – potentially even cancerous – and that the deposition of particles from biomass burning events can operate as efficient delivery systems for aero-allergens. Worryingly, research published by Forsberg et al in 2005 – entitled ‘Comparative health impact assessment of local and regional particulate air pollutants in Scandinavia’ – estimated a lifespan reduction in Sweden of approximately seven months due to the long-range transportation of pollutants.

FORGING A CLEANER FUTURE

Moving forwards, there is an urgent need for further insights to be made into the far-reaching consequences of large-scale biomass burning and the transportation of atmospheric pollutants. Yet, in the face of changing climate patterns, intensified human activities and the introduction of new emission control strategies, it is becoming progressively challenging to chart and predict the future emissions and deposition patterns in Northern Europe. Studies must take into account climate change trajectories, increasing risks for large-scale wildfires, as well as results of the increased extraction of natural resources and rising levels of sea traffic. Building on their previous findings, Karlsson, Hole, Tømmervik, Kobets and other colleagues are eager to continue their research in this area.

Biomass burning in Russia

In Russia, biomass burning is a hazardous practice that represents one of the main sources of wildfires and black carbon emissions. Due to the weak agricultural infrastructure, many Russian farmers see burning as the only economically viable way of clearing crop residues – and there are currently no clear guidelines regarding the public responsibility of fire management.

However, these fires can easily spiral out of control, spreading to forests and peatlands where they are capable of wreaking serious environmental damage. Although the Russian Federation prohibits the burning of agricultural waste by law – specifically, in its ‘Rules establishing the Fire Prevention Regime’ – enforcement of the ban is feeble and there is little control over the extent of these agricultural fires in practice.

Moreover, there is limited reliable data available on the scale of the wildfires. Indeed, figures on the quantity of the fires and the acreage they affect – published by Russian agencies such as the Ministry of Emergency Situation and the Federal Forestry Agency – tend to vary wildly. In turn, this absence of official statistical data makes it difficult to implement policies and management practices to address the seasonal variations in agricultural burning activities. Unfortunately, the privatisation of previously nationalised forests has created regulatory challenges in delivering fire control strategies on the small forest plots of the private leaseholders.

“Alternative methods of embedding crop residues into the soil require additional investments into more sophisticated techniques of soil treatment, additional expenses for fertilisers and more fuel for technical equipment,” points out Elena Kobets, Program Director for Development at the Bellona Foundation, an environmental non-profit organisation that is headquartered in Oslo, Norway. “Additionally, it is necessary to set up and finance consultation services for farmers in order to help them with the implementation of these methods.”