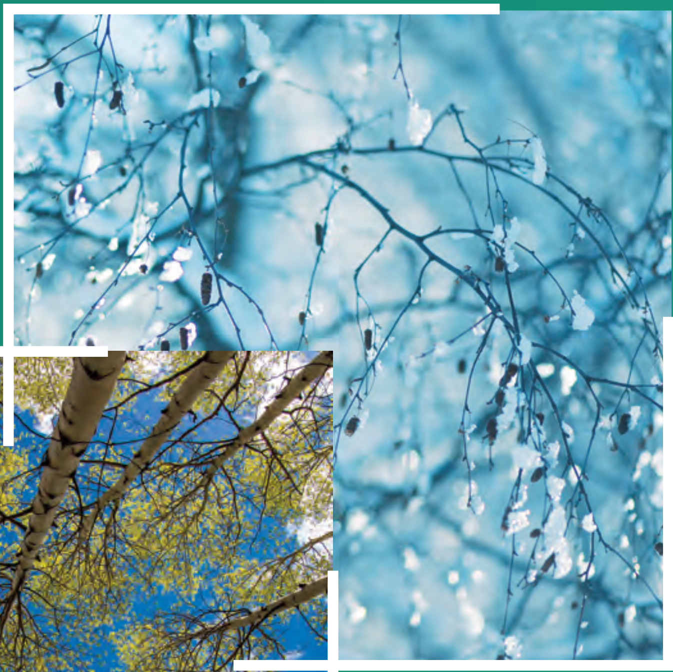

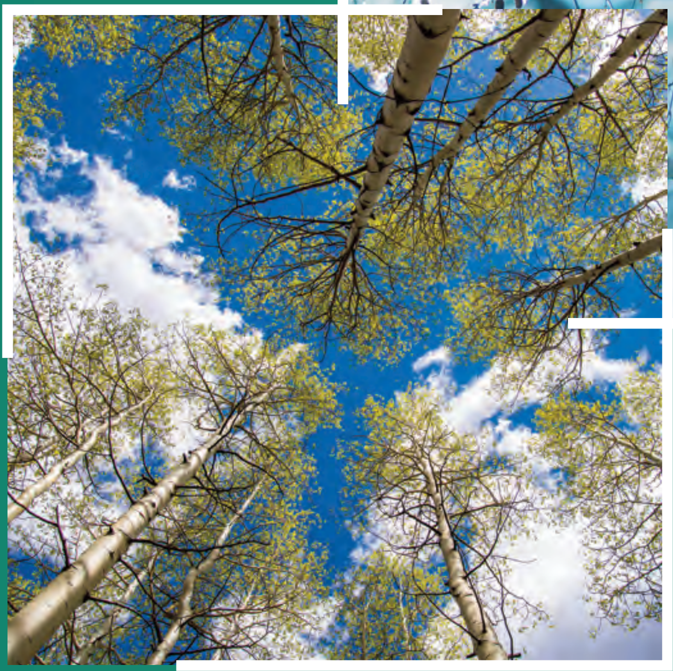

Taken by surprise: trees facing climate change

High aspirations for Norway in Horizon 2020

Arvid Hallén, Director General of The Research Council of Norway sheds light on how the country will benefit from the Horizon 2020 programme and the opportunities it will present…

Horizon 2020 is an extensive knowledge bank under construction, and it would be unthinkable for Norway as a nation not to participate in this wide-ranging initiative.

It is widely accepted in Norway that taking part in EU-funded research projects gives research communities the opportunity to join important European networks and cooperate with top-notch researchers abroad. Norwegian research policy is based on this premise, and in general the priorities of Horizon 2020 are in line with Norwegian priorities. The Norwegian government has formulated an ambitious strategy to increase the country's participation in Horizon 2020.

Horizon 2020 offers major benefits to Norwegian research and trade and industry

Norway, too, must find ways to resolve societal challenges ranging from an ageing population to renewable energy, and the country cannot do this on its own. Horizon 2020 will play a valuable role in the development of Norwegian research, trade and industry. Increased participation in Horizon 2020 will promote greater internationalisation of Norwegian research, thereby raising the level of quality overall. Further societal impacts are expected in the form of greater innovation, new products and markets for industry and a stronger ability to meet future challenges.

Norway: an attractive partner

Norwegian researchers have achieved good success in the previous framework programmes in fields such as climate, energy, marine and polar research. A number of Norwegian research institutions are world leaders in these fields. As such, they are attractive as partners for their European counterparts and can make an important contribution to dealing with societal challenges at the European level.

Norway possesses unique longitudinal data series, with information about health, education and other socio-economic factors for large segments of the population over long time periods. The potential of these data series for comparative studies in the health and social sciences should be better exploited by national, as well as international research groups.

Great expectations for Norwegian participation in health-related projects under Horizon 2020

The goal for participation under the Horizon 2020 challenge "Health, demographic change and wellbeing" is to double the number of successful projects compared with the FP7 Health programme, and bring Norway's level up to that of its neighbouring countries, Sweden, Denmark and Finland. The Research Council of Norway is funding 9 national Centres of Excellence (SFF) and 4 national Centres for Research-based Innovation (SFI) within the field of health to build and strengthen research groups of top international standard. Norway also participates in the EU's Joint Programming Initiatives (JPIs) on health and is involved in health-related infrastructures at the European level.

Norway's national biobank is a vital infrastructure for the health sciences. The biobank provides a basis for outstanding research and innovation, enhances Norway's ability to participate in international research projects and makes Norwegian research institutions attractive partners for comparative studies. There is also major potential for the further development of health clusters.

Specially-targeted Norwegian support schemes

The Research Council has initiated several funding schemes to support Norwegian participation in Horizon 2020. This includes funding to cover expenses in connection with the preparation of grant applications and support for institutions taking part in policy discussions at the European level.

Norway has a comparatively large number of independent research institutes outside the university and university college sector. These institutes must be competitive and able to respond to the need for research-based knowledge in both industry and the public sector. The Research Council has introduced a targeted support scheme to encourage these institutes to take part in EU-funded projects.

Arvid Hallén, Director General, Research Council of Norway

The Research Council seeks to align national research programmes and funding schemes with the priorities of various European networks, while facilitating access to the European research front for Norwegian researchers.

We are currently expanding our staff dedicated to mobilising and guiding applicants to more successful participation in Horizon 2020. The Council advises Norwegian researchers to apply for funding under Horizon 2020 before applying for national funding, when possible. Given political willingness and focus, targeted funding instruments and the growing interest in and understanding of researchers of the significance of the EU research arena, we have great expectations and high aspirations for Norwegian participation in the world's largest research programme.

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Investing in the future of agriculture

Phil Hogan, Commissioner for Agriculture and Rural Development at the European Commission details the importance of investment and innovation in agriculture…

Agriculture is humankind's primary occupation – the only economic activity which can be truly said to nourish the world.

The principle of food security needs to be a top priority for policymakers. However, while the challenges of enhanced food security and reduced food waste are not new, it is opportune for all actors – as guardians of the agricultural sector – to renew our commitment to these principles, and resolve to widen and deepen our structures for cooperation.

Europe has a deep well of experience in shared agricultural governance. We have reformed our Common Agricultural Policy, which operates in the 28 member states of the EU and its 500 million citizens, to be more dynamic and market oriented.

As a result we have seen considerable investment and innovation flowing into agri-businesses. Our goal is to consistently and sustainably produce high quality product for consumers the world over.

We believe this makes sense, and that our policies will deliver food security, incentivise waste reduction, nurture the environment, but also – crucially – demonstrate that working in agriculture can be good business, particularly for younger people.

Giving farmers the freedom to participate in the global market will serve all these goals. Let me be clear: the subsidies and protectionism of another era are gone, and we must all adapt to the 21st Century accordingly, and with confidence.

Nonetheless, targeted measures can incentivise farmers to play their part in our shared ambitions. Intelligent policy and sound governance can be real catalysts for change. Together, we must develop sustainable food systems and focus the international debate on increasing productivity, while continuing to address climate change and the sustainable management of natural resources.

We must promote a knowledge-based agriculture, strengthening research and innovation, and bridging the communication gap between farmers, researchers and agri-business. By transmitting research outcomes to farmers, and incentivising them to participate in the right research projects, we unleash their potential to drive the changes we are discussing here today.

Agriculture has always been an innovative sector, but the global food imperatives are now of such a magnitude that we need to innovate more, and innovate faster, if we are to achieve our goals. Agriculture must continue to become more productive and more efficient.

We must therefore continue to strengthen the Agriculture Market Information System and enhance the contribution of the annual Meeting of the Agriculture Chief Scientists, through the framework of the G20.

We must broaden the burden of food waste reduction to include the manufacturing, retail and consumer levels. Indeed, the main players in these sectors must begin to take a greater degree of responsibility in this shared challenge, and I encourage them to engage constructively in the coming months.

We must likewise focus on reducing on-farm and post-harvest losses for farmers.

Finally – and crucially – we must create the enabling environment to bring the private sector fully into this equation: productivity and sustainability cannot be achieved without investment. This means developing appropriate and accessible financial instruments on multiple levels, to provide farmers with the finance to support the significant on-farm investment required to facilitate these changes. This is a model we are currently pursuing with vigour and determination in the European Union.

Phil Hogan, Commissioner for Agriculture and Regional Development at the European Commission

Our fundamental shared challenge is this: how can we increase production while respecting our natural resources and reducing waste – how can we produce more, using less?

The EU “farm family” has 28 members, with differing needs and expectations, and we have learned many lessons during our shared journey towards a modern agricultural policy. We are willing, and committed, to sharing this bank of knowledge with our global partners.

In Europe, we consider our farmers to be custodians of the soil. As policymakers, our aim is to give them the tools and supports to produce more food – efficiently, productively, and sustainably.

Let us therefore resolve to work together, in every possible forum, with every willing partner, to provide the global leadership needed.

Europe stands ready to play its part.

Phil Hogan
Commissioner for Agriculture and Rural Development
European Commission
http://ec.europa.eu/commission/2014-2019/hogan_en

Taken by surprise: trees facing climate change

Challenges trees face

Climate change is one of the most serious global challenges to ecosystems and societies. Models of the Intergovernmental Panel for Climate Change (IPCC) project that with current emission levels the mean ambient surface temperature will rise by 2.6-4.8°C at the end of the century. The north and east of the Nordic regions will warm substantially more, exceeding what most forest eco-systems will be able to handle. While agriculture might benefit from a longer growing season and from expansion of cereal cultivation northwards, the situation for Nordic forests is more ambiguous. IPCC and the International Union of Forest Research Organizations (IUFRO) project that forest distribution and species composition will change drastically. The impact will be substantial, as an estimated 55-75% of Northern Europe is covered by forests. Forests are important as reservoirs of biodiversity, and as wildlife habitats. In addition, they represent substantial economic value, provide societal, health and recreational benefits, and mitigate climate change by storing carbon dioxide. Warming may also result in more frequent weather instabilities, with unusual fluctuations in humidity and temperature. Some areas will experience increased precipitation, while other areas will become drier and hotter. More frequent storms and pest outbreaks are likely to increase die-off and decay of many trees. Although warming might temporarily increase carbon dioxide (CO_2) storage in temperate forests, migration-related forest destruction and increased conversion of organic soil matter may turn forests into carbon sources.

Seeing the trees

There is a saying: 'Not seeing the forest for the trees', which means so much as not seeing the bigger picture, and having eye for the details only. Scientifically, the opposite is necessary. Detailed information from lower levels facilitates the understanding of higher-level phenomena. To understand the impact climate change might have on future forests, it is necessary to 'have our eyes on trees'. More specifically, we need to pay attention to the parts of a tree, and gaze even deeper into their tissues. In particular, we need to understand meristems. They contain the stem cells that are the ultimate source of the tissues that make up a tree. How does a tree protect its delicate meristems in winter? How will this capacity be compromised when the environment loses its faithfulness, and becomes erratic? 'Not seeing the trees' would give a blurred picture of the impact of climate change. In the following, we explain our research on meristems, and the strategies trees have evolved to cope with inhospitable seasons. Specifically, we discuss the concern that weather instabilities will compromise the ancient and fine-tuned interplay between trees and their environment.

Tree architecture

We investigate birch and poplar, two representative deciduous tree species that both are common in the boreal and temperate climate zones. They have relatively long life spans, and grow over many seasons, during which intricate branching patterns arise. Each species confirms to an 'architectural model', a concept that refers to the genetic framework upon which the tree becomes constructed. The complexity of the crown arises through internal competition of branches, and in interaction with the environment. The first phases in the life of a young tree or 'sapling' are crucial to its survival. During its first year hybrid aspen (poplar family) grows as fast as possible, investing everything in the quest for light. At the shoot apex sits a tiny meristem with rapidly dividing cells. This so-called shoot apical meristem is a remarkable centre of cell renewal and pattern formation. It tirelessly produces leaves that with almost mathematical precision are arranged around the stem in a species-specific phyllotactic pattern. Simultaneously, the apical meristem distributes to the axils of emerging leaves cells that form daughter meristems, which in turn develop into side-buds and branches. Meristems not only underlie tree architecture, they are also crucial in flowering, fruit production and overall survival. We therefore are investigating how they are organised and how they function.

Communication is key

In a seed, the shoot apical meristem arises as an integral part of the embryo, but after germination, it functions as a highly autonomous, self-regulating developmental entity. This is illustrated dramatically by classic microsurgery experiments, which show that excised meristems can regenerate into complete plants, whereas halved meristems can give rise to two complete meristems. The intact meristem is a marvel in itself, as it maintains its characteristic organization despite the fact that it continuously produces and releases cells to the growing shoot. This implies that individual cells behave in accordance with the position they occupy in the meristem. We therefore proposed a model that depicts the meristem as dynamic, robust, and self-organizing. In contrast to the situation in animal cells, this does not involve reshuffling of cells, as plant cells are immobile. Plant cells are born by cell division inside expanding cell walls, as if rooms were internally subdivided and then enlarged. During enlargement they displace other cells toward the periphery, where they exit the meristem. Maintenance of the overall organization of the meristem requires that cells communicate their position and local tasks to the other meristem cells in a dance of reciprocal signalling. The signals, signal paths, and the specifics of the network are poorly understood.

We have shown in early work, that numerous minute communication channels interconnect all meristem cells into an online cell community. These channels, called plasmodesmata, can be in an open or closed state, but they can also be opened wide by some proteins that are required for tasks in the adjacent cells. Some of these proteins are transcription factors, which shuttle themselves to neighbouring cell to regulate gene expression. At specific positions in the meristem, plasmodesmata are shut, defining boundaries and functionally subdividing the cell community. Cells are group-wise coupled into communication compartments, called symplasmic fields, where cells share metabolites and small signalling molecules. The central field of the meristem harbours stem cells. An additional layer of communication, prevalent in animal cells, is present in the form of excreted signal molecules. These signals bind to receptor molecules, embedded in cell membrane of the neighbouring cells, evoking a response. Interestingly, the two most crucial genes, WUSCHEL and CLAVATA3, which maintain the balance of the proliferating meristem, utilise a signalling network that engaged both, plasmodesmata and membrane bound receptors.

Sensing the environment

The symplasmic channels that form the communication nexus of the meristem are vulnerable to low temperatures. Trees in temperate zones therefore carefully monitor the environment to fine-tune their growth cycle to the changing seasons. How they achieve this is not well understood. We do know that trees monitor the length of the day and that, when day length has dropped below a critical value, they execute a winter survival strategy even if temperatures are still high. Day length is measured by a system of photosensitive pigments in the leaves that give input to a so-called molecular clock, which in turn sends signals to the meristems. The signals are delivered via the phloem, a living tube system that transports sugars from the leaves to growing areas, but which simultaneously is an information highway that conveys long-distance messages. The shoot apical meristem responds instantaneously to the timing signals by ceasing the production of elongating shoot parts, and switching to a program of terminal bud formation. The terminal bud, as well as the side buds, are survival packages that contain a compressed shoot system that kick starts growth in spring.

Deep sleep

The establishment of a dormant state completes terminal bud formation. We have discovered that the cells of the meristem are physically decoupled from the communication network that they collectively maintain. Decoupling is an effective measure to arrest supracellular developmental activities, and prevent premature flushing. It is achieved by installing specific structures at the entrances of plasmodesmata, which block the passage of molecules between cells. These structures function as circuit breakers in the symplasmic circuitry of the meristem, turning a society of communicating cells into a collection of off-line individuals. The isolated cells then turn inward, and change gene expression to redirect cellular physiology toward a freezing-tolerant, dehydrated, and low-metabolic state. Dormancy initiation thus appears to have the dual function of arresting developmental patterning, and priming for freezing-tolerance, both of which are essential to survive Nordic winters.

Untimely wake-up calls

Our work has shown that chilling induces the expression of genes that encode enzymes that hydrolyze callose, a sugar polymer that constitutes the blocking agent in the circuit breakers at plasmodesmata. Sufficient chilling removes the callose, de facto restoring the symplasmic communication network. Nonetheless, communication is minimal under low temperatures when meristems are in a state of relative dehydration, and the metabolic activity that is left is redirected towards cellular survival. Long-term chilling not only releases dormancy, it also increases freezing tolerance. As a consequence, the inactive but non-dormant system will become highly freezing tolerant, but poised for rapid growth once temperatures rise in spring. During this awakening process, meristems rapidly lose their freezing-tolerance, a process called de-acclimation.

The fine-tuning of the tree's life cycle, based on photoperiod recognition and chilling-responsiveness, functions beautifully in native species when the climate is faithful. A worry is that climate instability might change this. Because terminal bud formation, dormancy, and leaf abscission are regulated by photoperiod, their timing in the autumn is not expected to change. A potentially serious danger is that once dormancy is released by chilling, usually in the early part of winter, long warm spells in mid-winter can awake the buds. As a result of such untimely wake-up calls, cells can de-acclimate and lose freezing-tolerance, leaving them vulnerable to returning frost. It is not likely that this would kill a tree, although repeated atrocities might do so, but it will compromise wood quality through the death of leader shoots and the resulting erratic branching patterns. At present, we know too little about how heat sums will affect

meristem awakening in different species to make any precise predictions.

That climate change might compromise the fine-tuned relationship between plant meristems and their environment has received little attention in climate models. We urgently need to increase our knowledge and understanding of the survival strategies forest trees rely on, and the degree of resilience they confer. We hope for a growing awareness of the urgency of climate change among policy makers, the public, forest owners and forest-based industries. Norway supports forest research, among others through the Norwegian Research Council, who has financed most of our research in the recent past. We anticipate that our focus on trees and their meristems will help to generate much-needed knowledge to enrich 'the bigger picture', which will benefit Nordic forests, under threat of climate change.

Listening to trees

Trees, as a final note, have value beyond the above. Their yearly cycle marks seasonal progression and visualizes the rhythmicity of life. In parks and forests, they create spaces for physical activities, retreat and reflection. Trees mean more for our well-being than we might realize, and their sheer beauty, longevity and size arouse creative inspiration. Tree rhythms found their audible expression in a violin concerto, by John Williams, premiered at Tanglewood in 2000. The concerto, named 'Tree Song', has three movements: 'Doctor Hu and the Metasequoia', 'Trunks, Branches, Leaves', and 'The Tree Sings'. For who has eyes and ears.

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