
HUN-REN Hungarian Research Network

ACADEMIA EUROPAEA BUDAPEST HUB

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*Conveners:*

**Sierd Cloetingh** (HUN-REN EPSS, UU)

**Katalin Solymosi** (AE Budapest Hub, YAE, ELTE)

## RATIONALE AND SCOPE

A close connection exists between Earth system dynamics, Earth environment and quality of the human habitat. The latter includes access of an increasing world population to fresh water, sustainable energy and food amid climate change and various anthropogenic pollutions. All these aspects are of paramount importance for healthy living.

This workshop brings together leading scientists, experts and stakeholders engaged in facing these issues with different complementary backgrounds. The aim is to intensify the dialogue between Earth and environmental sciences and life sciences, establishing novel interdisciplinary connections, creating a platform to promote frontier research and innovation to address urgent societal needs. These issues are by definition of global and pan-European nature, but also particularly relevant for the Danube basin.

HUN REN Institute of Earth Physics and Space Science

ACADEMIA EUROPAEA BUDAPEST HUB

YAE

TOPO EUROPE

MTA HUNGARIAN ACADEMY OF SCIENCES

## 24th April 2025

| | |
|---|---|
| **9.00** | ***Balázs Gulyás***<br>Opening and welcome |
| **9.20** | ***Katalin Solymosi***<br>Introduction of the AE Budapest HUB and SAPEA |
| **9.40** | ***Sierd Cloetingh***<br>Introduction to the workshop |
| ***10.00–10.30*** | ***COFFEE BREAK*** |
| | **SESSION I: EARTH SYSTEM AND ENVIRONMENT** |
| **10.30** | ***Sierd Cloetingh (HUN-REN EPSS, Sopron; Utrecht University)***<br>Coupled Surface to Deep Earth Processes: Perspectives from TOPO-EUROPE with an Emphasis on Climate- and Energy-Related Societal Challenges |
| **11.00** | ***Taras Gerya (ETH Zürich)***<br>Bio-Geodynamics |
| **11.30** | ***Reinhard Hüttl (EEI Eco-Environment Innovation GmbH, Berlin)***<br>Soil Sciences and the Nantesbuch Initiative |
| **12.00** | ***Pietro Sternai (University of Milano)***<br>The Interplay Between Geology and Climate: The Slow Breath of Earth's Living Machine |
| **12.30** | ***Laura Petrescu (NIEP Bucharest)***<br>Unconventional Earthquakes: Peeking Inside the Vrancea Seismicity |
| ***13.00–14.00*** | ***LUNCH BREAK*** |
| | **SESSION II: RENEWABLE GEO-ENERGY** |
| **14.00** | ***Gábor Tari (OMV, Vienna)***<br>Natural Hydrogen: Where Do We Stand? |
| **14.30** | ***Eszter Békési (HUN-REN EPSS, Sopron)***<br>Geo-Energy Research at HUN-REN EPSS: Status and Future Advancements |
| **15.00** | ***Bernhard Novotny (OMV, Vienna)***<br>Deep Geothermal Energy for Decarbonizing the City of Vienna |
| ***15.30–16.00*** | ***TEA BREAK*** |
| **16.00** | ***János Szanyi (University of Szeged)***<br>Geothermal Energy Utilization |
| **16.30** | ***Mark van der Meijde (University of Twente, Enschede)***<br>Geothermal Energy from Large and Hot to Local and Cool Systems: Concepts and Options for Monitoring |
| **17.00** | ***Márta Berkesi (HUN-REN EPSS, Sopron)***<br>$CO_2$-rich Fluids from Greater Depth: Connection of Deep Earth with the Human Habitat |
| **17.30** | Challenges and Opportunities |
| ***17.45*** | ***DRINKS*** |

## Day 2, 25th April 2025

### *LIFE SCIENCES AND HEALTHY LIVING*

### SESSION III: FEEDING HUMANKIND AND HEALTHY LIVING

| | |
|---|---|
| **9.00** | ***Tom Beer (Safe System Solutions Pty Ltd, Brunswick)***<br>Climate, Wildfires, Air Quality and Health |
| **9.30** | ***Katalin Solymosi (ELTE Eötvös Loránd University, Budapest)***<br>Challenges of Sustainable Agriculture |
| **10.00** | ***Phoebe Koundouri (Athens University of Economics and Business)***<br>Integrated Assessment Models for Transforming Food Systems under Climate, Biodiversity and Food Security Threats: A Systems Approach |
| **10.30** | ***Péter Török (University of Debrecen)***<br>Grassland Restoration in the Anthropocene: Challenges and Opportunities for a Sustainable Future |
| **11.00–11.30** | **COFFEE BREAK** |
| **11.30** | ***Péter Nagy (Hungarian National Institute of Oncology, Budapest)***<br>European Initiatives to Improve the Integration of Cancer Research, Prevention and Care |
| **12.00** | ***Balázs Gulyás (HUN-REN HQ, Budapest)***<br>Frontiers of Healthy Ageing |
| **12.30** | ***Péter Hegyi (Semmelweis University, Budapest)***<br>From Science to Sustainable Health: Transforming Education and Research into Real-World Impact |
| **13.00** | Challenges and Opportunities |
| **13.15** | Future Initiatives and Follow-up |
| **13.30–15.00** | **LUNCH BREAK** |

### HOST

**Balázs Gulyás**, President HUN-REN (gulyas.balazs@hun-ren.hu)

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# BOOK OF ABSTRACTS

## ACADEMIA EUROPAEA – HUN-REN

# INTERDISCIPLINARY WORKSHOP ON EARTH, ENVIRONMENT AND HEALTHY LIVING

**24-25 APRIL, 2025**

**HUN-REN HQ**

*BUDAPEST*

HUN REN | Institute of Earth Physics and Space Science

MTA HUNGARIAN ACADEMY OF SCIENCES

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# SESSION I. EARTH SYSTEM AND ENVIRONMENT

## Coupled Surface to Deep Earth Processes: Perspectives from TOPO-EUROPE with an Emphasis on Climate- and Energy-Related Societal Challenges

***Sierd Cloetingh***

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Understanding the interactions between surface and deep Earth processes is important for research in many diverse scientific areas including climate, environment, energy, georesources and biosphere. The TOPO-EUROPE initiative of the International Lithosphere Program serves as a pan-European platform for integrated surface and deep Earth sciences, synergizing observational studies of the Earth structure and fluxes on all spatial and temporal scales with modelling of Earth processes. This review provides a survey of scientific developments in our quantitative understanding of coupled surface-deep Earth processes achieved through TOPO-EUROPE. The most notable innovations include (1) a process-based understanding of the connection of upper mantle dynamics and absolute plate motion frames; (2) integrated models for sediment source-to-sink dynamics, demonstrating the importance of mass transfer from mountains to basins and from basin to basin; (3) demonstration of the key role of polyphase evolution of sedimentary basins, the impact of pre-rift and pre-orogenic structures, and the evolution of subsequent lithosphere and landscape dynamics; (4) improved conceptual understanding of the temporal evolution from back-arc extension to tectonic inversion and onset of subduction; (5) models to explain the integrated strength of Europe's lithosphere; (6) concepts governing the interplay between thermal upper mantle processes and stress-induced intraplate deformation; (7) constraints on the record of vertical motions from high-resolution data sets obtained from geo-thermochronology for Europe's topographic evolution; (8) recognition and quantifications of the forcing by erosional and/or glacial-interglacial surface mass transfer on the regional magmatism, with major implications for our understanding of the carbon cycle on geological timescales and the emerging field of biogeodynamics; and (9) the transfer of insights obtained on the coupling of deep Earth and surface processes to the domain of geothermal energy exploration.

Concerning the future research agenda of TOPO-EUROPE, we also discuss the rich potential for further advances, multidisciplinary research and community building across many scientific frontiers, including research on the biosphere, climate and energy. These will focus on obtaining a better insight into the initiation and evolution of subduction systems, the role of mantle plumes in continental rifting and

(super)continent break-up, and the deformation and tectonic reactivation of cratons; the interaction between geodynamic, surface and climate processes, such as interactions between glaciation, sea level change and deep Earth processes; the sensitivity, tipping points, and spatio-temporal evolution of the interactions between climate and tectonics as well as the role of rock melting and outgassing in affecting such interactions; the emerging field of biogeodynamics, that is the impact of coupled deep Earth – surface processes on the evolution of life on Earth; and tightening the connection between societal challenges regarding renewable georesources, climate change, natural geohazards, and novel process-understanding of the Earth system.

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Invited Review Article

# Coupled surface to deep Earth processes: Perspectives from TOPO-EUROPE with an emphasis on climate- and energy-related societal challenges

Sierd Cloetingh[a,*], Pietro Sternai[b], Alexander Koptev[c], Todd A. Ehlers[d,e], Taras Gerya[f], István Kovács[g], Johannes Oerlemans[h], Fred Beekman[a], Yan Lavallée[i,j], Donald Dingwell[j], Eszter Békési[k,a], Kristóf Porkolàb[k,a], Magdala Tesauro[l,a], Alessio Lavecchia[m], Svetlana Botsyun[n], Veleda Muller[b], François Roure[o], Enrico Serpelloni[p], Liviu Matenco[a], Sébastien Castelltort[q], Donato Giovannelli[r,s,t,u,v], Alberto Vitale Brovarone[w,x,y], Nadia Malaspina[b], Giovanni Coletti[b], Pierre Valla[z], Jon Limberger[aa,a]

# Biogeodynamics


## *Taras Gerya*

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It is increasingly well understood that the coupled Earth interior, surface, climate and biosphere evolution is critically shaped by its unique global tectonic style - plate tectonics. The intrinsic couplings between plate tectonics, volcanism, surface processes, landscape, climate and biosphere are the subject of an emerging field of Biogeodynamics, which aims to understand and quantify these complex relationships by combining observational and modelling approaches. Here, I review recent advances of Biogeodynamics and discuss their implications for the uniqueness, development and longevity of global human civilization. I demonstrate that the development of technological civilizations on terrestrial planets requires long-term coexistence of subaerial continents, deep oceans and plate tectonics, which is very rare in the universe. I furthermore discuss how and why the speed of adaptation of the terrestrial biosphere to carbon degassing critically influences climate evolution dynamics on the timescales of millions of years. I show that the physical long-term carbon-landscape-climate system is more sensitive to biological dynamics than previously expected, which needs to be taken into account for developing long-term global climate change policy. Last but not least, I outline prospective of investigating Future Dynamics by exploring different long-term global and regional biogeodynamical evolution scenarios for the future development of technological human civilization included into and partly controlling key biogeodynamical cycles on Earth.

# Soil Sciences and the Nantesbuch Initiative


## *Reinhard Hüttl*

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Soils are the thin skin of our planet forming the uppermost part of earth's crust. As a natural resource soils are vital for present and future generations. Sustainable use of soils is a prerequisite for solving major global challenges. As an ecosystem service provider, soils fulfill important functions: they store carbon, they influence the climate, they maintain biodiversity, and they provide us humans with food, clean water, biomass and various raw materials. Soils are also the basis of human economic activity and functioning economies.

With this in mind, the non-profit Nantesbuch Art and Nature Foundation has made the topic soil the focus for its further development. Despite the importance of healthy soils for us humans and our future, there is not sufficient awareness of the relevance of soils, particularly of living soils. Hence there is an urgent need of improving soil awareness across society.

The basis of this initiative is the development of a long-term and internationally oriented soil competence network with experts and decision-makers from all relevant areas with a systemic, i.e. transdisciplinary approach.

A further concept of this initiative is to inspire art and culture through soil-science specialists in order to provide people with an aesthetic approach to this topic in addition to communicating relevant facts and findings from the various fields of fundamental and applied soil sciences, relevant neighboring disciplines as well as integrating knowledge in a truly interdisciplinary process.

# The Interplay Between Geology and Climate: The Slow Breath of Earth's Living Machine

***Pietro Sternai***

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The Earth is a living machine, its slow breath driven by countless interactions between geologic processes and climate dynamics. While traditionally studied as separate domains, recent research reveals profound cause-and-effect relationships linking the Earth's 'spheres' - from the depths of the lithosphere and below, to the atmosphere above. Modelling serves as a powerful tool to bridge these connections, integrating diverse observations across vast spatial and temporal scales. In this seminar, I will illustrate some of the hidden feedbacks between the planet's internal and external systems, discuss the challenges of unravelling these complex interactions, and highlight their critical importance in addressing and mitigating the extreme global changes reshaping our world today.

# Unconventional Earthquakes: Peeking Inside the Vrancea Seismicity

***Laura Petrescu***

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Earthquakes release large amounts of energy and are typically associated with the brittle failure of rocks. However, beyond a certain depth, deformation transitions from brittle to ductile due to increasing temperature and pressure, making classical brittle failure less likely. Deep earthquakes usually occur within slabs along active subduction zones and other plate boundaries. However, some exceptions challenge our understanding of earthquake mechanics. Among these are intraplate seismic nests, which remain enigmatic.

The Vrancea Seismic Zone is one such seismic nest, alongside Bucaramanga and Hindu Kush. Vrancea is characterized by an almost vertical cluster of intermediate-depth earthquakes beneath the southeastern Carpathians, far from any active plate boundary. Subduction in this region is thought to have ceased around 9 million years ago, yet destructive and frequent seismicity persists, even at depths where classical models would not predict it.

In this presentation, I will explore theories on the sources of Vrancea seismicity, possible generation mechanisms, and the characteristics of seismic clustering in the region. I will also examine the distribution of stress and its implications for brittle failure and dehydration embrittlement, as well as possible relations with ambient mantle flow. Ultimately, this talk will highlight how seismic nests like Vrancea challenge traditional views of earthquake generation and provide insight into the complex interplay between past and present geodynamic processes.

## SESSION II. RENEWABLE GEO-ENERGY

# Natural Hydrogen: Where Do We Stand?

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The fundamental question in natural hydrogen exploration is whether it is emerging as a process comparable to established practices in the hydrocarbon industry. There are papers published just in the last few years suggesting that many items in our collective industry and academic toolbox could be readily applied to natural hydrogen exploration. The consensus appears to be that most of the petroleum systems elements the industry tends to focus on in exploration projects largely overlap with those of the natural hydrogen system.

From an exploration point of view, several play types for natural hydrogen indeed appear to be very similar to what the oil and gas industry is used to. These include cases where there is a functioning trap, due to effective top seals. Numerous examples can be found in pre-salt traps worldwide where hydrogen has been documented for a long time as part of existing natural gas accumulations. Another, but unusual trapping style has been documented in the first hydrogen field discovery in Mali where the top seal is a set of dolerite dykes. In these cases, one expects finite hydrogen resources to be in place and the exploration approach has indeed some resemblance to that of hydrocarbon prospecting.

Another group of natural hydrogen targets revolve around large mega-seeps (fairy circles) and geometrically smaller but pronounced fault-controlled seepages to the surface. These hydrogen occurrences seemingly have no traps or seals and, therefore, do not find a proper analogue in oil and gas exploration workflows. Strictly speaking, these are not yet hydrogen plays as there are no commercial discoveries associated with them. The hydrogen fluxing along fault planes requires a fresh look at the exploitation of various fault architectures if shallow drilling would target conductive (or “leaky”) faults at shallow depth. The promise of this set of plays is that if these seeps really correspond to ongoing charge in a dynamic, truly renewable system in a steady-state process, tapping successfully into them would provide sustainable resources via a low-flux hydrogen “farming” process.

It is quite likely that natural hydrogen exploration, if it becomes economically successful at one point, will look much more different than similar to hydrocarbon exploration.

# Geo-Energy Research at HUN-REN EPSS: Status and Future Advancements

***Eszter Békési***

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In light of the energy transition, alternative geo-energy resources such as geothermal energy is gaining increasing attention, and natural hydrogen as a new potential energy source is recognized. While geothermal resources have long been utilized worldwide, natural hydrogen potential is largely unexplored, with only one operating field in Mali (West Africa). For the expansion of the geo-energy sector, explorational and exploitational advancements are required, which can be most efficiently achieved with the joint efforts of governmental, industrial and academic players.

The HUN-REN Institute of Earth Physics and Space Science (HUN-REN EPSS) has a wide range of competences relevant for geo-energy research at its disposal. First studies on Hungary's notable geothermal resources and on globally distributed natural hydrogen seeps have been conducted in EPSS, providing basis for the future expansion of geo-energy research. The main interest of EPSS in the near future lies in the assessment and exploration of geothermal resources in Hungary through integrated geological-geophysical analysis, imaging, and modelling, as well as the analysis of geological risks (such as induced seismicity and land subsidence), and the sustainability of production. In addition to geothermal research activities, the development and application of exploration and monitoring techniques for natural hydrogen are also an important future target within EPSS. Such geo-energy activities are planned to be conducted through international cooperations building on already existing connections with leading institutes and will further be expanded through participation in European geo-energy organizations and research projects.

# Deep Geothermal Energy for Decarbonizing the City of Vienna

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Sustainable energy sources are needed to achieve Vienna's goal to become climate-neutral and independent of fossil fuels in the future. Deep geothermal energy plays a special role here, as the utilization of geothermal energy from great depths is an emission-free, clean, and safe alternative for heating buildings without having a big areal footprint. Cause of suitable geothermal reservoirs beneath the city of Vienna and the third-largest district heating network in Europe, the Austrian capital is having all prerequisites for a geothermal development. Additionally, the Vienna Basin is well known as a hydrocarbon bearing basin and its subsurface was therefore studied and drilled numerous times by the oil & gas industry resulting in a big amount of data and decades of expertise dealing with the subsurface.

Wien Energie, the local Viennese energy supplier, and OMV, the Austrian energy and chemicals company, are therefore pooling their expertise in their recently found joint venture 'deeep Tiefengeothermie GmbH' to develop and utilize deep geothermal energy in the greater Vienna area in the future. Wien Energie and OMV have already worked together in the exploration of the geothermal potential of the central Vienna Basin and have been able to collect comprehensive data and findings as part of the "GeoTief Wien" research project. Within this R&D project existing subsurface data of the central part of the Vienna Basin were collected, analyzed, and re-interpreted. Additionally, a new 3D seismic was acquired over the area of interest in the years 2018/2019. The Aderklaa Conglomerate Formation, a Neogene fluvial braided river system, was selected because of specific geothermal reservoir properties.
Currently 'deeep' is planning the first geothermal plant with the first wells currently being drilled. This should be followed by a field development, lifting a geothermal capacity of approximately 200MWth within the next 10 years. Ultimately, more than 50% of the heat in the heat distribution network should be sourced by deep geothermal energy and industrial heating pumps. This together with the usage of waste heat, sustainable optimization of the customers and another important geothermal pillar, seasonal heat storages, should let the City of Vienna achieve the goal of having a climate neutral heating grid by 2040.

# Geothermal Energy Utilization

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Geothermal energy is widely known for its reliable, weather-independent and renewable nature, and it is commonly used in many countries all over the world for power generation purposes and heat applications including heat pumps. However, the use of geothermal energy, is very uneven within the EU space, conditioned by several aspects: geological, technological and political. At the same time, geothermal energy generates significant socio-economic and environmental benefits when compared to other energy sources.

Though geothermal energy is present everywhere in the crust, its most common methods of exploitation have been, until recently limited to a relatively few sites where the heat carrier (i.e. water) is easy to access, has high enthalpy (specific energy) and is of great abundance. Technologies referred to as Enhanced Geothermal Systems (EGS) provide opportunity to tap heat from great depths in areas with little or no thermal water and other new utilization options too have emerged. The development of these technologies can turn otherwise barren or unattractive geological environments into geothermal prospective/attractive environments. The potential for geothermal energy production to extract metallic minerals from deep geological formations is a subject of considerable interest. In this technology, the metal-containing geological formation would be manipulated in such a way that cogeneration of energy and metals is possible and can be optimized in the future according to market needs. This new technology could substantially decrease Europe's dependency on both the import of critical metallic minerals and of energy, over and above it has a small environmental footprint, including very low carbon emissions. Another possibility for geothermal energy is that subsurface geological formations provide enormous capacity for energy storage. The Geothermal Battery Energy Storage concept is proposed as a large-scale renewable energy storage method. The cyclically stored fluids are expected not only to be stored safely, but to be reclaimed efficiently making the underground energy storage the largest battery ever.

Achieving a low carbon and sustainable economy involves energy transition from fossil fuels to renewable ones. Geothermal is base load renewable energy that complements the intermittency of solar and wind energy. Geothermal energy plays a crucial role in the Clean Industrial Deal in Europe. It is a main contender in diversifying the energy supply and the large scale integration of Earth's heat into the energy mix. Geothermal is a major step towards a sustainable future!

# Geothermal Energy from Large and Hot to Local and Cool Systems: Concepts and Options for Monitoring

***Mark van der Meijde***

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Most of the geothermal research and production is focussing on large scale geothermal systems with (relatively) high temperatures. We studied and monitored in detail an active geothermal production location in the African Rift System in Kenya where we focussed on understanding the concept and functioning of the geothermal motor. We run a multi-year deployment of a passive seismic network which we used to image the source of the geothermal energy and the structure and dynamics of the system.

There are, however, many places on Earth that do not have high temperature systems, unless you drill very deep. Considering the challenges of the energy transition where geothermal heat can be used to significantly reduce the use of hydrocarbons for heating houses, it might be beneficial to also explicitly look at options for small-scale geothermal applications with (relatively) low temperatures. One concept that we are presently exploring for geothermal heat production in The Netherlands is the Low Unit Cost concept, a small-scale geothermal plant that can be easily incorporated in the build-up environment. It has low flow rates, works under low pressures, and should be used in its direct environment.

This overview will cover both large and small geothermal exploitation, and highlights the differences in use, but also the commonalities in the concept of the geothermal motor.

# $CO_2$-rich Fluids from Greater Depth: Connection of Deep Earth with the Human Habitat


***Márta Berkesi***

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Fluids (volatile substances such as $CO_2$, $H_2O$, $SO_2$, $H_2S$, CO, $CH_4$, noble gases) play a fundamental role in the formation, maintenance and termination of planet Earth processes including the climate. In addition to the obvious fluid-containing potential of the atmosphere and the hydrosphere, current scientific knowledge indicates that the solid rocky parts of the Earth and the deeper Earth spheres (e.g. the asthenosphere) are also characterised by a significant and complex fluid capacity. In the latter case, the question readily arises whether the large fluid resources in the Earth's deeper zones could affect human habitat, i.e. the shallow zones of our planet.

The transport of magmas from deeper than the lithosphere (greater than 65-70 km in the case of the Pannonian Basin) to the surface is a plausible example, since melts are associated with significant fluid transport. Nevertheless, the complexity of the fluid/rock system is illustrated by the fact that deep lithospheric and asthenospheric fluids can reach near-surface depths without active volcanism, being capable to present in groundwater, soil and atmosphere. Fluid inclusions representing different layer of the deep Earth, numerical temperature and fluid flow modelling along with isotope compositions of inclusions and groundwaters can significantly help to contribute to the understanding of the geologic $CO_2$ flux at mantle degassing sites.

# SESSION III. FEEDING HUMANKIND AND HEALTHY LIVING

## Climate, Wildfires, Air Quality and Health


***Tom Beer***

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Past President, International Union of Geodesy and Geophysics (IUGG)

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Sustainable Development Goal 13 refers to climate action. In Australia one of the most visible manifestations of a changing climate are wildfires that appear to be becoming larger and more frequent. This was recently demonstrated, just before the Covid19 pandemic, when the 2019-20 Australian fire season was the longest with active fires, and destroyed the most homes since fire records have been kept. This led to increased realisation of the risk due to climate change of wildfires (always known as bushfires in Australia). In 1988 my CSIRO colleagues and I produced the first scientific examination of bushfire danger under climate change. The paper was based on a scenario of the expected climate in 2030 and states that the fire danger every year on average would be larger than the fire danger during the year in which the terrible Ash Wednesday fires occurred. This already seems to have occurred. Humidity plays a very important role in determining which years will and will not have bad bushfires. Thus, science has advanced to a stage where we can mathematically determine fire spread, the likelihood of fire occurrence, calculate air quality implications and even publicise the dangers that low visibility causes because of bushfire smoke. I remain optimistic that science, engineering and technology, working for and with society, will find solutions to the growing challenge of wildfires and climate change.

# Challenges of Sustainable Agriculture


## *Katalin Solymosi*

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Agriculture faces several highly complex challenges that intertwine environmental, social, and health concerns, reflecting the intricate balance required to feed a growing global population while mitigating anthropocene-related environmental pollution and climate change related impacts. Novel agricultural practices should be adopted to ensure food security amidst changing climatic conditions. The latter results in extreme precipitation with both inland water and flooding as well as drought and extreme temperatures leading to reduced crop yields and threatening agricultural productivity. Environmental pollution, stemming from industrial or agricultural runoff including the overuse of agrochemicals (e.g. fertilizers and pesticides), poses risks to ecosystems and human health, perpetuating a cycle of degradation. The excess application of fungicides has led to the emergence of resistant fungal pathogens, posing threat both for agricultural output and human health. Decreased soil quality, including soil salinization, diminishes arable land, compromising long-term food production capacity. Furthermore, inefficiencies in the food processing chain contribute to significant food waste, squandering resources and exacerbating food insecurity.

The One Health concept underscores the interconnectedness of human, animal, and environmental health, highlighting the need for holistic approaches to agricultural sustainability. Since 2022, I have been a member of the Academia Europaea Task Force for Environment, Sustainability and Climate which aims to improve the inter- and transdisciplinary dialogue around these topics.

In summary, addressing the challenges of sustainable agriculture demands integrated strategies that prioritize environmental stewardship, resilience to climate impacts, and public engagement to ensure a sustainable future for generations to come. In this introductory lecture I plan to present a few examples, case studies and open research questions of this highly complex field.

# Integrated Assessment Models for Transforming Food Systems under Climate, Biodiversity and Food Security Threats: A Systems Approach


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Integrated Assessment Models (IAMs) are critical computational frameworks for analyzing complex agricultural and food systems. This comprehensive review examines twelve prominent IAMs, systematically categorizing them into four specialized sub-groups: Food Security and Socio-economic Models, Hydrological Models, Land and Crop Production Models, and Food-Energy-Water Nexus Models.

The research evaluates each model's methodological capabilities, including computational strengths such as cost optimization algorithms, interdisciplinary integration depth, and spatiotemporal resolution. By synthesizing diverse modelling approaches, the study provides a systematic assessment of IAMs' potential to simulate intricate interactions within agriculture and food ecosystems.

We assess twelve Integrated Assessment Models (IAMs) focused on food systems using five key criteria: (i) cost minimisation, (ii) addressing the nexus of water, food, energy, land use, and climate, (iii) integration with other models, (iv) sectoral coverage, and (v) spatial and temporal resolution.

We highlight tangible areas of refinement to enhance the models' interoperability and their added value for policy formulation. These include downscaling IAMs to local contexts or specific agricultural sectors, integrating economic, energy, AFOLU, and climate data and outputs, with a preference for indices that span multiple sectors, and developing a shared query tool that gathers individual data sets from original data sources.

Key findings underscore IAMs' strategic importance in supporting evidence-based policymaking, particularly within the European Union's sustainability frameworks. The analysis demonstrates how these models can generate nuanced scenario projections, facilitating more informed decision-making processes across scientific, policy, and stakeholder domains.

# Grassland Restoration in the Anthropocene: Challenges and Opportunities for a Sustainable Future

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Grasslands are vital landscape elements of most continents covering approximately 40% of the terrestrial land surfaces. Only in Europe, nearly 800 000 $km^2$ of grasslands are present providing various ecosystem goods and services ranging from water regulation to pest control and sustaining millions of grazing livestock. Grasslands suffered high area loss in the last century and their biodiversity is threatened by land-use change and agricultural intensification. They are essential landscape elements in landscape-scale biodiversity conservation, so their effective conservation and restoration has utmost importance. In the “Decade of Restoration (2021-2030)” declared by the United Nations, most restoration actions and related communication targeted forest restorations and the boost of carbon sequestration by tree planting. Various agendas including also the biodiversity strategy of the EU aims to plant trillions of trees. In contrast, a much lower awareness is given to open habitat restorations including also grassland restoration, despite the fact that especially in arid regions, carbon sequestration of grasslands exceeds that of tree plantations. It is also stressed that the aim of restoration should not be the carbon sequestration but biodiversity conservation of threatened habitat types. In the current presentation I aim to summarise the most important challenges and opportunities of grassland restoration and outline the importance of these treeless habitats in a sustainable agriculture and human well-being.

# European Initiatives to Improve the Integration of Cancer Research, Prevention and Care


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In the past two decades effective immune and targeted therapies, robotic surgery and state-of-the-art technology driven extreme precision radiotherapy introduced a new era in oncology. Personalized oncological treatments entail the need for more in-depth diagnoses. Hence, molecular diagnostics together with AI-based radiological and pathological procedures are now becoming part of routine cancer care in developed countries.

This rapid evolution increased global as well as pan-European inequalities, which is reflected in mortality rates. Furthermore, the Organization of European Cancer Institutes' quality control program could clearly demonstrate that research active institutions provide better outcomes for their patients, which underlines the need to integrate cancer research and care in Comprehensive Cancer Centers.

In my presentation I will highlight a few European initiatives, which are dedicated to improve cancer prevention as well as patient centered oncological care together with addressing inequalities within Europe, such as the ECAC5, UNCAN.4EU, CCI4EU or ECHoS projects. I will also show the Hungarian example how integrating research and care can indeed provide immediate as well as long term benefits for our cancer patients.

### Key references


Simon Oberst et. al. 100 European core quality standards for cancer care and research centres, **Lancet Oncology** (2020) 21, 1009-1011.

Eric Solary et. al. UNCAN.eu, a European initiative to UNderstand CANcer, **Cancer Discovery** (2022) CD-22-0970.

Ulrik Ringborg et al. Strategies to decrease inequalities in cancer therapeutics, care and prevention, **Molecular Oncology** (2023)

Michael Boutros et. al. UNCAN.eu: Toward a European Federated Cancer Research Data Hub, **Cancer Discovery** (2024) 14(1):30-35.

Klaudia Borbényi-Galambos et. al. Realigned Transsulfuration Drives BRAF V600E-Targeted Therapy Resistance in Melanoma, **Cell Metabolism** (2025) in press

# Frontiers of Healthy Ageing


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Large cohort longitudinal studies in the world indicate that while our cognitive performance at population level is declining with ageing, at individual level a significant proportion (7-10 %) of elderly people can retain their high cognitive performance and in several cases they can even increase it. The scientific exploration of maintaining high cognitive performance with ageing can provide us with important clues and lessons. The lecture will provide the audience with an overview of the neurobiological basis of cognitive compensation mechanisms and give an outline of the recent research efforts in the field.

# From Science to Sustainable Health: Transforming Education and Research into Real-World Impact

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The foundation of sustainable healthcare lies in the ability to translate scientific discoveries into real-world applications. Despite continuous medical advancements, EUROSTAT data reveals that 1.7 million people die annually in Europe, with 1.2 million of these deaths being preventable through better primary prevention and public health interventions. A key barrier to achieving sustainable health is the gap between research and clinical practice, which stems from outdated educational models in both medicine and science (1).

Academia Europaea has introduced a translational cycle model to facilitate the effective integration of scientific knowledge into healthcare (2). This model emphasizes the need for a balanced approach that fosters medical innovation while ensuring that healthcare professionals remain up to date with the latest research. However, current medical education focuses heavily on theoretical knowledge and bedside practice, offering minimal training on how to interpret and apply scientific findings in clinical settings. Similarly, traditional research training often lacks a focus on real-world impact, slowing the translation of discoveries into tangible health benefits.

To address this challenge, we have developed a hybrid Ph.D./healthcare TM program that enables students to engage in scientific research and clinical practice simultaneously. Through a "learning by doing" and "retaining by teaching" approach, students acquire essential skills in critical appraisal, communication, and research methodology, ensuring that they not only consume but actively contribute to medical advancements (3). This model enhances their ability to produce high-impact, clinically relevant research while equipping them with the expertise needed to integrate new knowledge into practice.

For healthcare to become truly sustainable, education in both medicine and science must evolve. Integrating translational medicine principles into training programs will accelerate the implementation of scientific discoveries, leading to better patient outcomes and a more resilient healthcare system. To achieve this, Academia Europaea seeks collaboration with academic and healthcare institutions worldwide, working together to build a future where education drives sustainable health.

(1) Hegyi P, Erőss B, Izbéki F, Párniczky A, Szentesi A. Accelerating the translational medicine cycle: the Academia Europaea pilot. **Nat Med**. 2021 Aug;27(8):1317-1319. doi: 10.1038/s41591-021-01458-8. PMID: 34312557.

(2) Hegyi P, Petersen OH, Holgate S, Erőss B, Garami A, Szakács Z, Dobszai D, Balaskó M, Kemény L, Peng S, Monteiro J, Varró A, Lamont T, Laurence J, Gray Z, Pickles A, FitzGerald GA, Griffiths CEM, Jassem J, Rusakov DA, Verkhratsky A, Szentesi A. Academia Europaea Position Paper on Translational Medicine: The Cycle Model for Translating Scientific Results into Community Benefits. **J Clin Med**. 2020 May 19;9(5):1532. doi: 10.3390/jcm9051532. PMID: 32438747; PMCID: PMC7290380.

(3) Hegyi P, Varró A. Systems education can train the next generation of scientists and clinicians. **Nat Med**. 2024 Dec;30(12):3399-3400. doi: 10.1038/s41591-024-03315-w. PMID: 39420217