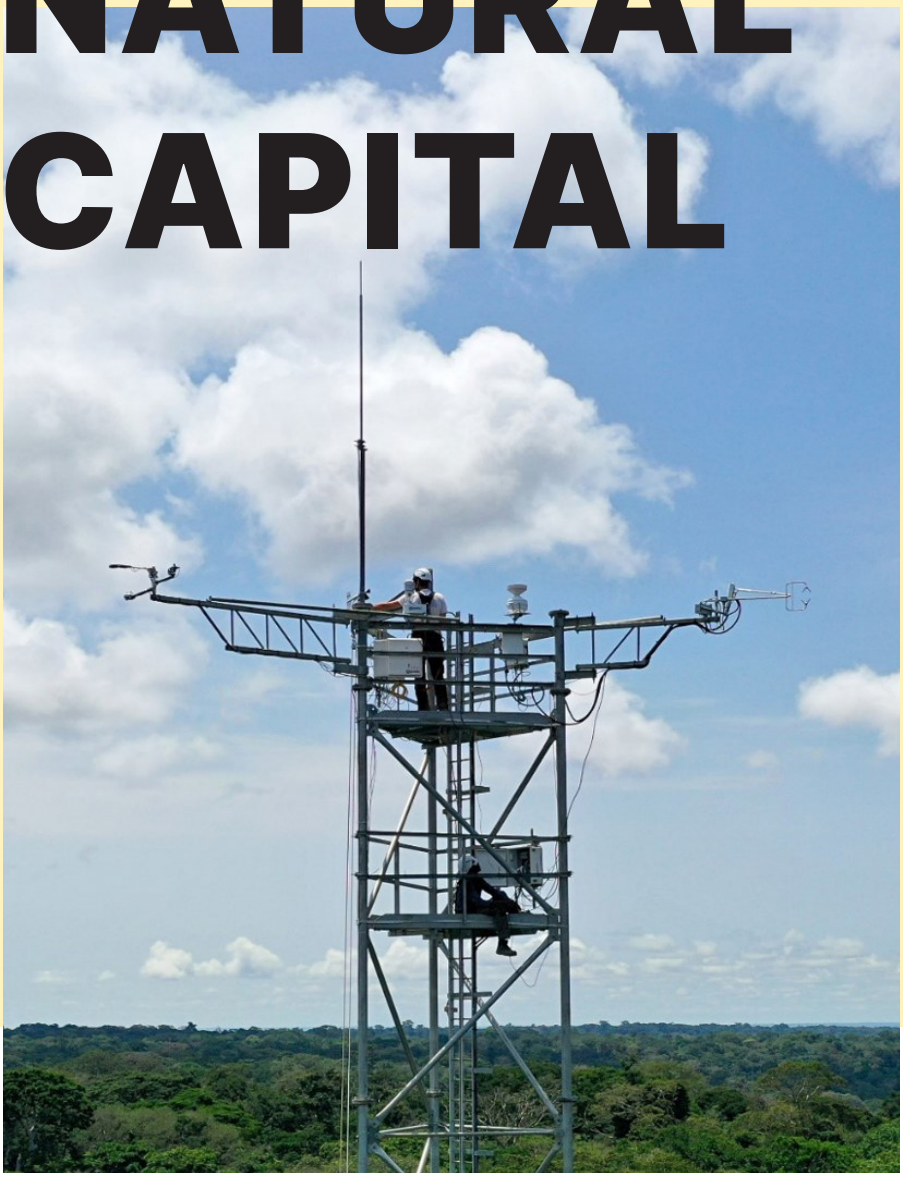
OUR NATURAL CAPITAL

April
2023



research needs and priorities for the future

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Further ideas were generated during discussions amongst the 50 participants at Prof. Ellsworth's Collen-Francqui chair closing symposium in December 2022.

How to cite

Ellsworth D, Verbeeck H, Soudzolovskaia N, Baeten L, Hubau W, Van Coillie F, Verheyen K et al. 2023. Our natural capital, research needs and priorities for the future. White paper, Natural Capital Research Platform, Ghent University, Belgium.

Vision on Natural Capital research

This document summarizes ideas that emerged during the international Collen-Francqui chair trajectory of Prof. David Ellsworth in Belgium (Sept-Dec 2022). From Australia, Prof. Ellsworth brings an external view towards the research community in Europe, formed during a series of Classes of Excellence in Belgium. These ideas emerged from the discussions with professors and young researchers attending the Classes of Excellence at seven Belgian universities, as well as with the members of the Natural Capital Research Platform of the Faculty of Bioscience Engineering at Ghent University. This document incorporated feedback and comments by 50 participants at Prof. Ellsworth's Collen-Francqui chair closing symposium in Dec 2022.

summary

Research designed to evaluate the impacts of environmental changes and extreme events affecting our natural capital, underpins effective decision-making for management and policy.

A vision for long-term research on natural capital and its sensitivities to climate change in a fragmented landscape has been formulated over an extensive consultation of scientists in Belgium.

Research designed to evaluate the impacts of environmental changes and extreme events affecting our natural capital, underpins effective decision-making for management and policy.

To achieve this, long-term research on natural capital, a landscape context, and a strong capability to quantify climate perturbations to ecosystem carbon cycles and belowground assets of ecosystems are considered crucial.

The human side of natural capital research is viewed as central to the next decade of advancement, and increasing training opportunities for young scientists in this area as well as building research capacity the global south are advocated.

Research innovation involving our natural capital is imperative to move forward on practical, management and policy decisions for climate change adaptation.

vision
& guiding principles

Natural capital research must prepare the society to understand impacts of environmental change and extreme events on natural capital, and enable equipping society with alternatives and effective mitigation and adaptation strategies against climate change.

A strong science-based landscape understanding is needed: one that is highly interconnected within Europe as well as the whole world, which focuses on ecosystems and ecosystem services and support processes, and with the capacity to recognise and cope well with the increasing human population, climate change and extreme event impacts on our natural capital.

An objective for the future is achieving a strong recognition of scientific research as the central basis for practical, management and policy decisions for climate change adaptation in Belgium, Europe and beyond, in a context of local and global sustainable development.

introduction

Natural capital entails goods and ecosystem services that originate in natural and semi-natural landscapes. Our natural capital contains enormous social, cultural and economic value, including tremendous value in regulating and mitigating global climate change. In spite of the fact that natural capital lies at the heart of our economy and is a cornerstone for human well-being, its stocks are being depleted (Maes et al. 2018). Profound challenges lie ahead for our natural capital: the global population, which just reached 8 billion people, is expected to rise to approximately 10 billion people by the middle of the 21st century and the global climate is predicted to change to a degree that ecosystems — and the natural capital elements that they deliver — will be threatened. Changing this trend for the better is what motivates this vision for natural capital research over the next decade.

Safeguarding and restoring natural capital for future generations therefore calls for urgent action. It is encouraging to notice that policy makers at all levels, from local to global, are becoming more and more aware of the urgency. This has resulted in an increasing number of policy initiatives aimed at securing and increasing our natural capital (e.g., the EU Green deal). The success of these policies integrally depends on the incorporation of scientific knowledge, but the information to underpin the policies as well as the science basis for decision-making must be strengthened. Both the Intergovernmental Panel on Climate Change (IPCC) and the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) aim to bridge the gap that exists between science and policy. However, platforms such as IPCC and IPBES rely on the efforts of scientists who work together to provide the most up-to-date information and insights. Truly integrated, interdisciplinary approaches are needed, given the holistic nature and complexity of natural capital. In this white paper, we formulate our vision and recommendations for Natural Capital research for the coming decade.

A series of 'ecosystem services' (defined as amenities derived from ecosystems from which we benefit in some manner), that are interdependent and represent aspects of our natural capital (Table below; the list includes selected examples) form a central part of the benefits from our Natural Capital. Our natural capital is too often taken for granted and undervalued in the capital marketplace, but we need to recognize that we cannot flourish without it.

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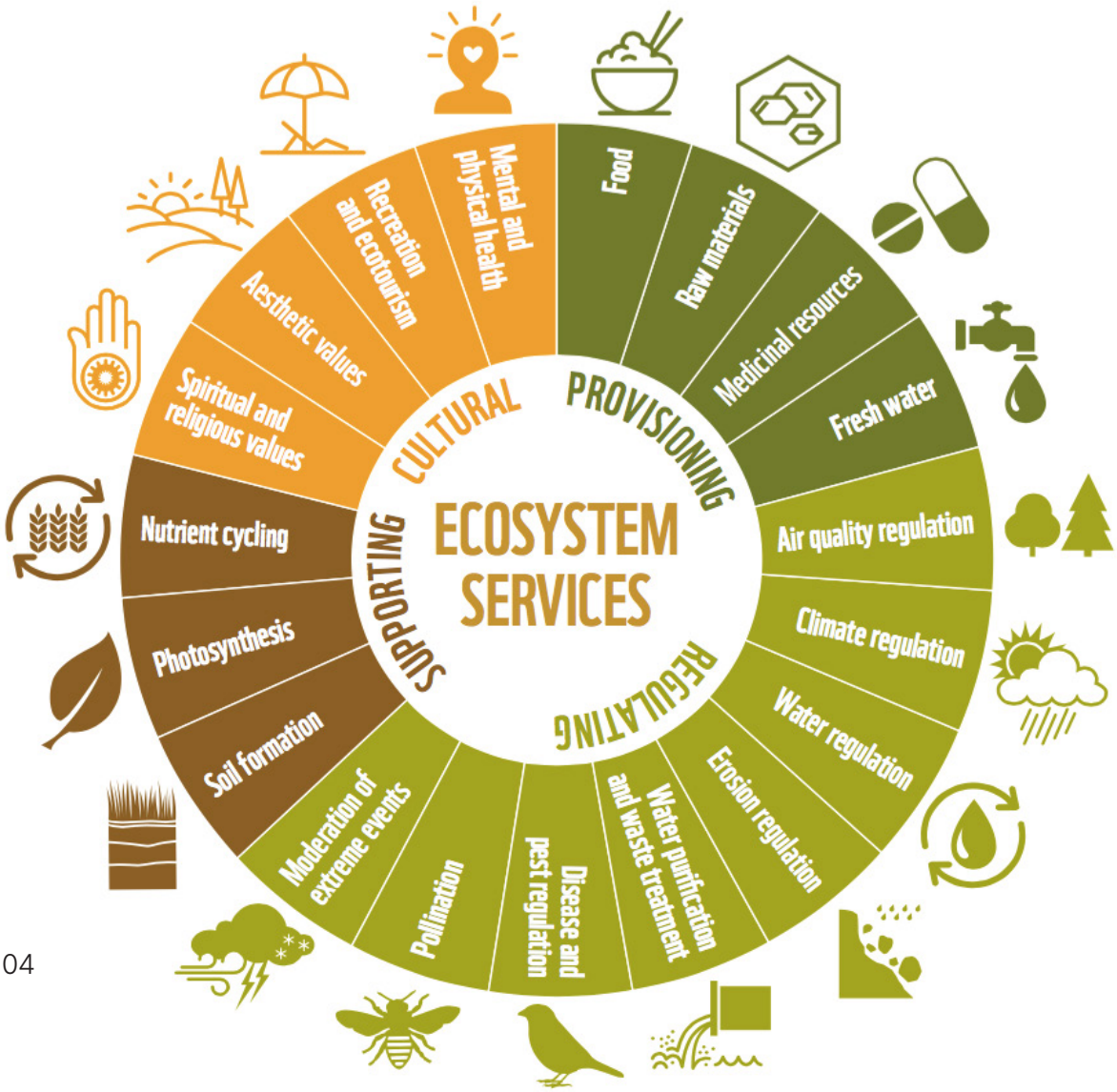

It is recognized that human activities have drawn-down our natural capital, particularly over the last 50-100 years. This depletion has happened as a result of (i) land conversion, land-use intensification and land degradation or even direct over-paving of land surfaces, (ii) global change agents and drivers (including rising atmospheric CO_2, environmental pollution and nutrient enrichment), (iii) biotic alterations and homogenization from biological introductions and subsequent expansion of invasive alien species and pathogens, and (iv) habitat degradation and water pollution of inland waters and marine environments, including the depletion of fish stocks due to overfishing. Trends and indicators for these 'ecosystem pressure indicators' for terrestrial and aquatic ecosystems provide strong evidence of substantial depletion of our natural capital in recent decades (Maes et al. 2018, European Environment Agency 2020). If we impact our natural capital too much through land degradation, global change and biotic invasions, then we erode the aspects of that capital on which we depend (see Table) and risk being unable to build that capital back at a later time. Moreover, there is a risk that compounding effects of various ecosystem stressors can aggravate negative impacts on our natural capital. Hence EU policies for climate neutrality by 2050 and outcomes from world forums such as the COPs might come too late for our natural capital and risk leaving us nearly bankrupt with regard to it. Some of this loss in natural capital in recent decades cannot be recovered and we need to consider ways to protect against or mitigate further losses to our natural capital. The challenges do not only lie within Europe, but globally. If we zoom out to identify the forefronts of the struggle against climate change, then the tropics stand out as one of the most important. They harbor the most biodiverse and carbon-dense ecosystems on our planet, but that strength is also their vulnerability. Worldwide coral bleaching, ramping deforestation rates in Southeast Asia and the Amazon, an increasing incidence of forest dieback in the Amazon, and a predicted fourfold increase in human population and subsequent smallholder forest clearing in Africa, are just some examples of the ominous peril closing in on these key ecosystems.

Some very recent high-level conferences have addressed the sensitivity of our natural capital to climate change and intensified efforts to reduce Greenhouse Gases (GHGs) and subsequently their impacts on climate. The 2022 COP27 UN Climate Change Conference in Sharm el-Sheikh in Egypt, following on from earlier such COP meetings, broadened GHG reduction targets to contribute to an overall reduction in all emissions for countries, including from the supply chain, and to cover the short, medium and long- term trajectories of GHG reductions. The series of COP for UN Climate Change Conferences have commitments towards mitigation, but mitigation does not fully protect our natural capital. In this aspect, agreements emerging from the COP15 UN Biodiversity Conference in Montréal in December 2022 are anticipated to bolster that aspect of our natural capital. Together with these agreements and commitments, research on natural capital needs to stay a decade ahead of the policies to ensure the proper basis for planning and decisions is laid forward.


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Relevant natural capital strategies for the EU

We now know that biodiversity underpins the functioning of ecosystems and the provision of natural capital elements that are essential to human wellbeing. The EU biodiversity strategy aims to put Europe's biodiversity on the path to recovery by 2030 and the strategy is outlined in a series of technical reports. For instance, the fifth technical report of the EU's Biodiversity Strategy (2018) provided an integrated analytical framework and set of indicators for mapping and assessing the condition of ecosystems in the EU, with culmination in the first-ever EU-wide Ecosystem Assessment 2020, released in May 2021. Further reports at the EU and international scale have been issued by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), an independent intergovernmental body.

The European Green Deal, including the Farm to Fork strategy, and the New European Bauhaus, aim to protect, conserve and enhance the EU's natural capital stocks through transformation towards a sustainable future. Europe's efforts to modernise and transform the economy with the aim of climate neutrality has achieved much in the last 5 years and provides an admirable goal for other world players, yet trends for our natural capital have yet to turn positive. Moreover, some of the strategies to achieve 'climate neutrality' themselves do not account for climate change vulnerabilities (e.g., counting the CO_2 sequestered by trees that are at risk of mortality due to climate extremes), nor does it guarantee that Europe's exported emissions are sufficiently addressed.

At the global level, Europe is found to be one of the biggest beneficiaries (second to China) of imported tropical deforestation. The European Commission tries to partly counteract this, e.g. through commitments on CoP26 (€1 billion to protect forests worldwide), CoP27 (additional support for climate change adaptation and resilience in Africa) and the biodiversity CoP15 ('historic' deal to protect a third of the world's biodiversity). As such, the tropics are now more firmly on the international policy radar, yet these pledges are small compared to what is needed to protect complex tropical ecosystems. Reinforcing research in the tropics is a logical addition to the vision for Natural Capital, especially given that long-standing research connections between EU and tropical (especially African) countries are already in place.

'Reinforcing research in the tropics is a logical addition to the vision for Natural Capital'

Current European research infrastructures, like ICOS strive to achieve monitoring of ecosystems and ecosystem processes. Other research infrastructures include AnAEE for experiments, lifewatch for biodiversity monitoring, STEREO and ESA for satellite imagery, eLTER for long term observational studies on ecosystems etc. Concerning these infrastructures, a key shortcoming for research on natural capital is the lack of long-term commitments for sustainability of these infrastructures, which potentially leads to paucity in ecosystem measurements and assessments. The short-term funding cycle of about 3 years, implies equally short research cycle, which is at odds with the long-term requirement (decade-long) for identifying impacts of climate extremes and compounding climatic events on ecosystem functioning.

Another shortcoming of current natural capital research is an over-emphasis on research in specific single land-use types (ex.: agricultural research, grassland or forestry research, urban ecology), hence driving management of these specific types and landscape fragments of them in isolation rather than as-a-whole landscapes in which these types are (co-)located and managed by a multitude of stakeholders.

key recommendations

Against the back-drop and perspective of further depletion of natural capital described above, a set of recommendations for research priorities for the coming decade are here offered to fill gaps in the Belgian and European research environment.

They were formed to ensure that natural capital research, and risks and opportunities for natural capital with climate change, remain a focus for research and science-based decision-making. They were also formed with the vision that future natural capital research should focus on transdisciplinary approaches in which science, policy, society and implementation go hand in hand and mutually reinforce each other.

The complexity of the natural capital challenges is large and knowledge, insights and perspectives from the broadest possible range of societal actors should be mobilized to design effective, sustainable nature-based solutions addressing these challenges.

1 towards an integrated landscape perspective

A 'Landscape Climate Challenge' should be an emphasis for future research. This challenge would be focused towards an integrated landscape assessment of natural capital and its multiple ecosystem services, for understanding their forcing by climate in a highly fragmented landscape. This would build capacity for multi-disciplinary and multi-university research efforts in the national interest of natural capital sensitivities to climate change in an integrated and landscape fashion. It would prioritise funding to bring together specialists in geography and GIS, near-surface (proximal) and remote sensing, plot-level soil and biological data, modelling and analytics, and so on to understand our natural capital at a landscape scale under a fragmented tapestry. A landscape perspective would also subsume the current restricted science focus on particular single sectors (agricultural, forest, urban ecosystems, etc.) or parcels in the landscape allocated to these uses, instead building towards the landscape scale for management and mitigation efforts and scientific understanding of compartments that are interconnected via flows of energy, biodiversity, etc.

These efforts could also involve an assessment of land-use alternatives to the current state via data-driven and systematic land-use planning, allowing for research on how effective these are for delivering multiple key ecosystem services to society. But also looking for scenarios that optimize co-benefits between climate as well as other environmental challenges such as biodiversity conservation, food security, soil fertility, integral water management, etc.

There is currently considerable competition between agricultural land use, semi-urban development, and natural capital conservation. This tension fuels the perception of support for either one or the other amenity and services they provide to the exclusion of potential synergies and co-existence of these land uses in the landscape. The link between urban and 'natural' landscape, connectivity of green spaces, and access to green space for people and biodiversity is included in this landscape assessment.

The 'Landscape Climate Challenge' could help broaden the view of such land-use practices as separate landscape entities, to instead consider the landscape holistically with multiple elements of natural capital that are provided by this whole. This integrated landscape perspective is the key to large-scale holistic and sustainable management in Europe.

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2 monitoring and understanding carbon-water cycles in a changing climate

Research to support efforts to get a better understanding of carbon cycles is needed. In particular work to better assess C sequestration above- and particularly below-ground needs to progress further, and include assessments of risks related to greenhouse gas emissions and reduced C sequestration from climate change and compounding climate events and climate extremes. Linkages between C sequestration and hydrology need to be better understood in the context of uncertain rainfall patterns with climate change. As an example, there is not enough basis in research including from ICOS, AnaEE and eLTER to assess nationally what the impacts of repeated droughts in Europe (2015, 2018, 2019, 2022) and heatwaves (2018, 2022) have been on soil C or ecosystem C sequestration for plot-level to the larger scale of landscapes to support a national outlook and C sequestration risk assessment. When research on above- and belowground C sequestration is realised, it should, where possible, consider additional ecosystem services that are synergistic with C sequestration. This should then provide for a balanced perspective for policy and land management decisions, that also includes a risk assessment framework associated with climate change.

3 enhancing soil health research

In reviewing the literature and experiments testing ecosystem sensitivities to global change factors, a significant science gap emerges time and time again: the lack of coherent and comprehensive belowground data in ecosystem experiments. For example, of over one thousand global experiments addressing ecosystem responses to global change drivers, nearly half lack much belowground data and less than one-ninth of these has assessed belowground C sequestration changes in response to these drivers.

It is time for renewed emphasis on the difficult and time-consuming but crucial belowground part of ecosystems and their key services, through advanced measurements and models (see also Van der Putten et al. 2023). This includes a renewed emphasis on soils and soil biology and their linkages to ecosystem functioning, including productivity as well as other aspects of biogeochemical cycles belowground that are central to the storage and release of organic carbon.

The sensitivity of belowground carbon to climate warming is palpable but requires further research to move the community towards a predictive capacity; whilst the effects of other factors such as drought and elevated CO_2 are less direct and hence less known but no less important.

4 accounting for interactions among climate stressors

Research on connections and interactions among different climate stressors is currently not sufficient, since often one climate driver like elevated atmospheric CO_2 drives another like climatic warming. Past experimental manipulations and still some current research have focused on single-factor drivers or agents of climate change (warming, rising atmospheric CO_2, etc.). Likewise, some experimental efforts have focused on climate warming rather than understanding multiple interactions such as warming x drought and even higher scale (3-way) interactions. With climate change, such conditions will co-occur and one factor can compound the other in terms of impacts on ecosystem services. Beyond direct climate drivers, secondary influences, such as changes in land stewardship motivated by changing policies or public expectations, may also deeply affect natural capital use. A large proportion of the research effort should be dedicated to tools like advanced models and techniques for analysing and understanding these higher-level interactions and direct versus indirect effects, which is required to address the real-world situation of adaptation to multiple, interacting and strongly intertwined factors.

5 building long-term observation schemes

A commitment to long-term research on natural capital is imperative – this allows for appropriate monitoring and validation sites in different ecosystem types (in Belgium and other regions where the Belgian research expertise is recognized, i.e. tropical Africa).

Currently, funding cycles do not support sufficient long-term science visioning, on the scale of a decade. In spite of this, real long-term measurements of stressors and ecosystem responses serve as an early-warning system for potentially harmful effects of global change drivers and for the detection of interactions and lag-effects. It is very difficult to distinguish cause and effect, or to distinguish between naturally occurring or human-induced effects without long-term monitoring that establishes a strong baseline against which perturbations can be evaluated. Long-term natural capital research could be integrated as a set of exploratories or super-sites.

The choice of the locations of long-term field observation sites (e.g., fluxnet sites, ICOS sites, AnaEE and eITER sites, etc.) is often ad-hoc, and historically done based on practical considerations and opportunities (research site of the university; selected ecosystem of specific research unit reachability & accessibility). As such, these sites do not necessarily capture the most representative ecosystems for assessing global change, or for calibration/validation purposes. Likewise, the availability of records on the historical state of ecosystems is scarce and depends on old inventory programs (e.g. phytosociological surveys) linked to searchable archives to match with present-day records. Hence, a set of core criteria for where long-term sites would be best located and identification of essential ecosystem variables to map global trends is needed.

As global studies ultimately rely on local observations, coordinated and well-designed monitoring schemes can further connect local to global assessments and back.

It is important to note that many key processes within ecosystems are either slow, subtle, rare or complex, or a combination thereof, which cannot be properly understood without a long-term follow-up of ecosystem functioning. Lastly, disturbances within ecosystems clearly have long-term effects, some of which are synergistic or cumulative, and these can be considered in models and planning if the appropriate long-term measurements have been done.

6 embrace capacity building

Capacity-building to advance training and development in adaptation to climate and land-use change is lagging behind, both in Europe and in outreach to the global south. Training for students researching natural capital should allow for joint MSc, PhD and cotutelles/similar programmes to be more commonplace, with funding organisations and government encouraging more joint degrees across institutions. This would include better cross-region joint initiatives, e.g. support for the preparation and presentation of Master's and doctoral theses co-supervised by professors at Flemish and Walloon institutions, or jointly across Belgian, European and overseas institutions (such as in Congo or other parts of Africa). A joint research-natural capital platform could be established to cross these boundaries, understanding that natural capital amenities and landscapes sit apart from regional boundaries. Further capacity-building can include retention of talented individuals at the post-doc to mid-career stages.

Capacity building in the tropics (e.g. Africa) is also a matter of empowering local researchers locally, by investing in infrastructure, by supporting them in training field and lab technicians, by involving them in all steps of the scientific process (from sampling to analysis, modelling and reporting), and by providing a budget they can manage independently. While financial support from Europe is essential to accomplish step-changes in our understanding of complex tropical ecosystems, we must avoid 'helicopter research' (flying in, collecting samples and leaving) but adopt an inclusive approach of collaboration instead. An important aspect of such an inclusive approach is to maximally involve local knowledge from indigenous people. We must understand that capacity building is not a charity, but a token of respect for ownership of local knowledge and a path to better, well-informed science.

7 switch to transdisciplinary collaboration for more science impact

The research efforts described above should also push forward towards broad transdisciplinary collaboration: collaboration in which research is integrally linked with implementation of nature-based solutions to climate change for and with communities. Transdisciplinary research involves co-creation with communities, civil societies, other stakeholders and researchers from different disciplines working collaboratively for joint problem-solving rather than individualised modules that come together (multi-disciplinary). Implementation of nature-based solutions should be done at scale (thus extending beyond scientific plots used in experimentation), and this implementation should go hand-in-hand with research via a genuine and continuous exchange between scientists and practitioners and stakeholders involved in both terrestrial and aquatic systems. An emphasis on improving science communication and a general understanding amongst decision-makers and the general public of the importance of our natural capital should also be a key element of the transdisciplinary collaboration.

To raise awareness, science communication is not enough. We need to put more effort into planning, capturing, communicating, disseminating and monitoring our research impact, i.e. changes we see in society, economy and environment attributable to our research. This requires an enabling environment with advisory staff, impact toolkits, action-research, co-creation etc. facilitating and paving the way towards improved research impact. This requires a strong involvement of researchers with the communities that allows to increase trust in the researchers and research solutions, and is built on mutual respect of each other's knowledge.

As climate change grows more poignant, we become increasingly dependent on tropical ecosystems, which are globally important providers of key ecosystem services and nature-based solutions.

8 include research in the tropics

We cannot deny the detrimental impact of European colonial history in the global South, yet the very significance of that period restrains us from turning a back to the tropics and particularly Africa. Apart from keeping the discussion on restitution, recovery payments or apologies alive, we should also invest in (scientific) capacity building, as described in recommendation #6. Yet we need to acknowledge that tropical countries do not just need us, we also need them - more than ever.

As climate change grows more poignant, we become increasingly dependent on tropical ecosystems, which are globally important providers of key ecosystem services and nature-based solutions. Where African nations are developing economies, they are giants when it comes to biodiversity, carbon sequestration and freshwater resources. Bluntly speaking, they serve both as our planet's (biodiversity) treasury and its (carbon) sponge, and we just cannot do without either of them.

Due to our past, Belgium and other European countries still have long-standing and strong connections and networks in the global south and especially in Africa. Paradoxically, these controversial historical ties provide opportunities for today and the future by investing in robust climate change research through an inclusive capacity building approach. These efforts are also needed to highlight how tropical ecosystems are connected with the rest of the world.

All key recommendations formulated above are of particular importance in the tropics. Because tropical ecosystems are relatively enigmatic (compared with Europe), our knowledge of the functioning of tropical soils is very limited, as well as the importance of compound effects of tropical climate stressors, or the interactions between tropical carbon and water dynamics. More than anywhere else, improving our understanding of tropical ecosystems requires transdisciplinary collaboration, and an integrated and long-term landscape perspective. To do this, we need to pool international and local researchers, and integrate indigenous knowledge into research and practice. A priority in the tropics, is setting up more joint research centers, joint research projects and exchanges for researchers between Europe and the tropics in a way that achieves a solid and high-quality cooperation in the domain of Natural Capital.

conclusion

An integrative and long-term research vision has been presented to galvanise and renew natural capital research in the next decade, and establish priorities and build synergies within the research community. Addressing the recommendations would improve the standing of our natural capital on a whole-landscape basis, present us with science-informed options and strategies against climate change, and enhance sustainable growth of our natural capital into the next decade.

Selected resources

- European Environment Agency 2020. State of nature in the EU: Results from reporting under the nature directives 2013-2018. Report no. 10/2020.
- European Union Ecosystem Assessment 2020 (Maes, J., Teller, A., Erhard, M., Conde, S., et al. 2020. Mapping and Assessment of Ecosystems and their Services: An EU ecosystem assessment), EUR 30161 EN, Publications Office of the European Union, Luxembourg, ISBN 978-92-76-17833-0, doi:10.2760/757183, JRC120383.
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