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Planning, Education and Art

for Austrian Climate Change Adaptation

Final Report

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StartClim2020.A: Norm2050: emission-reduced, climate-resilient building and living in Vienna in 2050

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StartClim2020.C: BELONGevity: Innovations for a socially inclusive and sustainable circular economy

KMU Forschung Austria: Harald Wieser, Viviano Wich

StartClim2020.D: Impact of different management on water- and carbon/nitrogen fluxes in inner-alpine grassland

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StartClim2020.E: Quantification of land use change and its consequences for soil carbon storage

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StartClim2020.F: Development of a method to measure the contribution of cover crops to carbon accumulation in agricultural soils

Bio Forschung Austria: Eva Erhart, Elisabeth Neuner

StartClim2020.G: “Homo sanus in caeli sano – a healthy person in a healthy climate”: potential synergies between health policy and climate policy (HICS)

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Table of contents

Abstract

StartClim has been studying adaptation to climate change since 2008. The projects in StartClim2020 addressed various research questions, such as climate-resilient building, barriers to pro-environmental decision-making, a sustainable circular economy, management for inner-alpine grassland, the quantification of land use change, and climate change in the arts.

Norm2050: Emission-reduced, climate-resilient building and living in Vienna in 2050

Post-modern society has seen an increase in urbanization on a global scale. People spend most of their lives primarily in building interiors in an urban environment that is strongly over-formed by buildings. Since the consequences of climate change are intensified by the urban environment, climate protection and climate change adaptation are of particular importance here as a means of maintaining living conditions that are conducive to health and well-being.

The design of the built environment is subject to numerous normative requirements. These legal instruments, some of which have been in place for a long time, are often not in line with the new conditions and requirements described above. The aim and content of Norm2050 is therefore to analyse regulations, laws, standards and procurement guidelines that are relevant for achieving emission-reduced, climate-resilient buildings and living in Vienna by 2050, to identify obstacles, contradictions or missing information and to derive recommendations for action. For this purpose, the five individual goals of the sub-area “Buildings” of the framework strategy “Smart City Wien 2019 bis 2050” have been studied in particular, with a special focus on residential buildings.

The updating of climate datasets as a normative basis for the calculation of building qualities is seen as particularly relevant, and a corresponding adjustment is recommended. For example, the calculation of heating and cooling requirements of buildings according to ÖNORM B 8110-5 is based on temperature measurements from 1978 to 2007.

The design of urban outdoor space is often dominated by road traffic regulations. Specifications in the sense of the defined goal are largely missing. It is recommended that binding guidelines be introduced for measures such as shading, evaporation, unsealing and vegetation coverage, in order to counteract the development of urban heat islands.

Furthermore, it is recommended that a deconstruction and recycling concept and a material building passport be made obligatory in the planning phase of renovation projects, but especially in the case of new buildings. Building assessment systems and certifications, such as klimaaktiv, the Austrian Sustainable Building Council (ÖGNB) or the Austrian Society for Sustainable Real Estate (ÖGNI) could act as guides. The legal basis for this could be provided by the Sustainability Guideline of the Austrian Institute for Building Technology (OIB RL 7 for Sustainability).

Why we fail to tackle climate change: exploring barriers to pro-environmental decision-making in the lab and field

While knowledge and awareness of the consequences of climate change are growing among the majority of the European population, environmental behaviour, for example in the field of nutrition, mobility or consumption, is changing only slowly. The underlying causes of this discrepancy between awareness and actual behaviour – referred to in the literature as the value-action gap – are manifold.

This project examined three barriers typical of many forms of environmental behaviour. These barriers can increase the psychological distance between choices and their consequences, making it difficult to translate environmental and climate attitudes into behaviour. (1) Lack of immediacy: the effects of environmental behaviour typically affect others and become apparent only with a time lag. (2) High uncertainty: the consequences of environmental decisions are often perceived as uncertain. (3)

Marginality: the contribution of individual behaviour to the prevention of environmental and climate impact is often perceived as minor.

This project used an innovative combination of laboratory and field experiments. In the laboratory setting, the causal influence of the three barriers to decision-making was identified in a climate change game controlling for contextual third variables (N=802). In the field experiment, environmental behaviour was studied in a real-world decision scenario considering donations for environmental forestation projects (N=652). The study results showed that with an increasing number of barriers, participants found it more difficult to translate their own environmental values into actions. The value-action gap increased when people were not affected by the consequences of their own actions (lack of immediacy), when it was uncertain to what extent their own contribution could support climate protection (uncertainty) and when the impact of their own contribution was considered to be only small (marginality).

The results of the project provide deeper insight into the barriers and problems people face when adapting to sustainable behaviour. These insights could be applied to the design of effective and inclusive environmental policies, in climate communication, in education, and in civil society engagement. In particular, it is important to reduce uncertainties and to show the relevance of individual behaviour for climate change mitigation, while also clearly highlighting the consequences of climate change for societies. The findings of this study could contribute to overcoming the manifold challenges in transforming behavioural patterns and thus promote efforts to achieve more sustainable societies.

BELONGevity: Innovations for a socially inclusive and sustainable circular economy

The transformation to a circular economy aims to use available resources more efficiently and thus make an important contribution to combating climate change and avoiding environmentally harmful waste. However, while such a transformation already enjoys broad support in politics and business, private households have so far remained largely unaffected by it. Against this background, this study discusses the opportunities and limits of the currently dominant approach of a “top-down diffusion” for a broad-based implementation of a circular economy from a social inclusion perspective and, building on this, develops building blocks for the design of circular and socially inclusive provisioning systems.

The study draws from both the scientific literature and an analysis of extensive empirical material. At its core are the observations from individual interviews and a joint workshop with eleven for- and non-profit organizations active in the circular economy, as well as qualitative interviews with ten private households. Further insights were gained through two workshops with circular economy experts and stakeholders.

This report shows that social inclusion in the circular economy is currently primarily addressed through compensatory measures such as the creation of jobs and income opportunities and discusses the shortcomings of such an approach. The subsequent analysis addresses the question of how a circular provisioning system can be designed to combine resource efficiency with social inclusion and what challenges arise in their implementation from the perspective of individual businesses and organizations. The resulting grid (Figure C-2) highlights the central components of socially inclusive provisioning systems along three dimensions that could guide providers and policymakers: creating diverse options for material participation, enabling barrier-free access, and proactively reaching out to disadvantaged people.

The experiences of the organizations and households studied show that a circular economy can facilitate material participation in various ways but at the same time creates specific challenges that can impede access. Furthermore, the analysis shows that circular start-ups in particular tend to target post-materialists in combination with an open-door approach, which can lead to the unintended exclusion of other social groups. The report concludes with a discussion of the importance of social inclusion for

the broad-based transformation to a circular economy and possible intervention points for policymaking.

Impact of different management on water- and carbon/nitrogen fluxes in inner-alpine grassland

In Austria, 1,258,809 ha are used for agricultural management. Of this, 31,123 ha are accounted for by meadows with one cut per year, 229,349 ha with two cuts, and 483,374 ha with three or more cuts (bmlrt.gv.at, 2021). Permanent grassland with two-cut meadows is the dominant agricultural management form in Austria at altitudes over 1,000 m.

Grassland yields are strongly dependent, among other things, on weather conditions in the growing season. As a result of climate change (IPCC, 2018), recent years have seen a strong increase in air temperatures, particularly in alpine areas. Because of higher air temperatures but the tendency to increasing precipitation in certain regions of Austria (APCC, 2014) the growing season is likely to become longer, and this phenomenon has even been investigated. More intensive grassland management is conceivable in future in favoured regions. The aim of this project was to investigate, how more intensive agricultural management of a representative montane grassland site (Oppenberg, Styria, Austria), affected yield, yield quality and soil-water balance.

The grassland management in the first treatment year 2020 under existing practical conditions, when a 250 m² area was equipped with seepage water collectors, soil sensors and a weather station, covered the period from 24 June to 19 August. After a dry spring, the 2020 growing season (April to October) was characterized by numerous precipitation events and higher air temperatures. The average seepage (measured from 12 May to 31 October) was 394 mm, 452 mm and 464 mm at depths of 30 cm, 60 cm and 90 cm, respectively (fig. 1). The measured precipitation in this period was 880 mm, giving positive soil water storage of 304 mm (30 cm), 246 mm (60 cm) and 235 mm (90 cm).

Because of the favourable weather conditions and positive water balance, the farm achieved a comparatively high grassland yield and, in fact, the high-yield rich aftermath was not fully grazed in autumn.

In the second test year 2021, more intense management (three cuts) was tested on the farm. For this purpose, on 8 June (the usual cutting dates for the first cut in the year 2021 in these regions was 18 June) a 125 m^2 large area was cut and then fertilized with cattle slurry. The yield, yield quality, water balance and carbon and nitrogen fluxes resulting from the intense management with three cuttings per year until September 2021 will be compared with the usual two-cut management.

Quantification of land use change and its consequences for soil carbon storage

The annual land take of agricultural land in Austria is far above the national target of 2.5 ha per day. Agricultural soils are enormous carbon sinks. We know little about how and whether national targets are known or implemented at regional and local levels. In this study we quantified the actual losses of agricultural soil since 1975 in seven municipalities and calculated the amount of soil carbon affected by the land use change. We also conducted twelve qualitative interviews with local decision-makers and regional/national stakeholders to understand the losses and obtain arguments for and against land use. There were large differences between communities. The total loss of agricultural soils ranged from 3.6 to 42.3 per cent. In the studied municipalities, a total average of 47.2 ha per year of agricultural soil has been lost since the 1970s, with 3.7 to 40.3 per cent of the respective soil carbon stocks in the municipalities being affected by the land use changes.

The proportion of high-quality soils in the municipalities ranged from 17 to 84 per cent. The soil quality did not play a role in land-take decision-making. The most important reasons given for soil consumption were land for housing, jobs and infrastructure. Arguments against soil consumption included social conflicts and social degradation and direct and indirect costs. We were able to classify several

communities as rural spatial types, and the land-use changes here corresponded to the typical spatial developments. Our interview partners suggested that there were major land-use conflicts that needed to be solved by systematic spatial planning.

Development of a method to measure the contribution of cover crops to carbon accumulation in agricultural soils

With the help of humus balancing, farmers can calculate for themselves how their cultivation affects the humus content of their soils and adapt their cultivation methods accordingly by means of humus-increasing measures such as the addition of organic fertilizers or cover crops so as to maintain or increase the humus content of their soils. In order to better assess the contribution of cover crops to soil-organic carbon storage, the results of Bio Forschung Austria (BFA) field trials were evaluated together with reports from literature. BFA data for above-ground cover crop biomass showed an average value of about 2,350 kg/ha DM (dry matter) for frost-killed cover crops and 4,300 kg/ha DM for winter-hardy cover crops. In older literature on humus balancing, an average of 2,100 kg/ha DM was given for frost-killed cover crops, and 4,430 kg/ha DM for winter-hardy cover crops. Root biomass was 1,690 kg/ha DM for frost-killed cover crops in the BFA trials. In older literature, the root biomass of frost-killed cover crops was far lower, averaging 927 kg/ha DM. The amount of root biomass assumed in the data on which a humus balance method is based is important, because cover crops and their roots promote microbial biomass, which is now considered the most important source of organic soil matter. Current meta-studies also indicate that the contribution of cover crops to soil-organic carbon is somewhat higher than calculated by the site-adapted humus balance method. Overall, the results indicate a need for partial revision of the humification coefficients for cover crops in the site-adapted humus balance method. However, after discussion with Dr Kolbe, who developed the method, additional confirmatory evaluations of recent continuous field trials are necessary. The longer a cover crop stands in the field, the more above-ground biomass, but also and more importantly, the more root biomass, which is essential for increasing soil-organic matter, it can form. Most of the positive effects of cover crops, both for soil-organic matter and for climate change adaptation, increase with the length of time a cover crop is in the field. Therefore, it would make sense to introduce a longer standing period for cover crops in the Austrian ÖPUL agri-environmental programme.

"Homo sanus in caeli sano – a healthy person in a healthy climate": potential synergies between health policy and climate policy (HICS)

The project "A healthy people in a healthy climate" developed consensual climate and public health goals together with actors from science, civil society and provincial agencies in Styria and explored possible policies. Consensual political goals can foster and guide new and solid political alliances. The project focused on climate change mitigation, which is often associated with sacrifice and therefore impedes the enactment and implementation of relevant policies. By linking the discussion of climate protection and public health, climate change mitigation policies could gain legitimacy by being framed as health issues and could emphasize the positive effects of climate-protection policies on the individual and societal quality of life.

Against this backdrop, twenty-one interviews with actors from Styria and beyond were conducted, positive visions of a future climate-friendly society in selected areas were screened in the scientific literature, and health impacts of selected climate protection and public health policy goals were quantified with the help of a literature search. Among the policies that actors mentioned and that are described in the literature, those regarding food and mobility have the greatest potential for synergies. Policies in these two areas could make a substantial contribution to climate change mitigation, and according to the literature, there is solid evidence that such policies have a positive public health impact. Further areas of climate protection policies are less conducive to such synergies for three reasons: there is insufficient data on public health impacts; public health impacts are difficult to quantify and assess

without ambitious modelling approaches; and corresponding climate protection policies are unlikely to have substantial positive public health impacts by themselves. The project recommends the development of a joint discussion by climate and health actors on increasing the share of plant-based food at the expense of animal-based food, and on more active mobility at the expense of motorized individual mobility. The focus should be on structural changes for degrowth of urban design, solidarity, deceleration, health promotion and regionalization.

Change of scenery

Many people have dystopian ideas and images of climate scenarios, which we as a society do not want. In order to make a climate-just future a reality, we need a counterbalance: ideas and images of what a climate-just future could look like if we manage to transform our society. However, many people are still unable to conceive what that might mean for future everyday life.

The change-of-scenery project told a science-based, graphic story of what this climate-adequate future could look like. It drew on images and stories derived from interviews with climate pioneers and scientists and complemented them with statements from the relevant literature.

Themes such as regionalization, changing values, a new kind of cooperative humanism and deceleration were frequently mentioned in the interviews. There was also much emphasis on the solar orientation of the energy system, new forms of mobility and an economy that operates in regenerative cycles. Other common themes were active citizenship and new forms of political participation.

Frequent statements were incorporated in scenes and given written profiles. In a 48-hour co-creative hackathon by the project team, final detailed scenes were selected and a matching landscape designed. A text to accompany the wallpaper elucidated statements that were difficult to represent graphically (e.g. inner attitudes). Remaining inconsistencies that emerged in a feedback workshop with stakeholders were eliminated. A making-of film was also produced to document the process.

The wallpaper provides inspiration for discussion that goes beyond consideration of loss and damage, addressing opportunities and added-value transformative changes, e.g., quality of life, health, social cohesion. The wallpaper can be downloaded online as a creative basis and can be printed for use at events (www.zukunftstapete.at)

ClimArtLab

In summer 2020, the Konrad Lorenz Institute for Evolution and Cognition Research (KLI) and the artEC/Oindustry think tank created ClimArtLab, a new space for transformative change that mobilizes transdisciplinary art-science collaborations with the goal of healing our planet. The first project of this transdisciplinary laboratory was “Evolving Futures: Owning Our Mess”. It emerged as a result of a dissatisfaction at mainstream approaches used to foster and understand behavioural and cultural change in both research and policy. Often, a nudging paradigm is used to shape the architecture of choice and to influence the behaviour of groups and individuals who are unable to motivate people to take responsibility and to act on their own behalf. Other times, a scaring paradigm is used, which leverages fear and insecurity that cause disempowerment and diminished agency. Our project stepped away from nudging or scaring and investigated positive stimuli that can create inner change and transformation through intrinsic motivation and transformative agency. The questions driving “Evolving Futures: Owning our Mess” were: How can we as individuals and society step away from fear and take responsibility for our mess? How can we develop intrinsic motivation and agency to address challenges related to climate change? How can artists and scientists work together towards the shared goal of supporting regenerative futures in times of climate emergency? We addressed these questions through creative and open-ended mutual learning and knowledge co-creation processes and interwove theories and practices from many scientific and artistic fields. We made use of theories of intrinsic motivation

and embodied cognition, mobilized complexity theories and nexus approaches to climate change, and experimented with participatory artistic installations and performances to explore new ways of creating inner change and transformation. Through mutual learning and experimentation we provided new entry points to think about and change the way in which we see our lives in the midst of the climate emergency. We used embodied experiences to shape and reflect upon our hybrid-cyborg lives. We intersected the digital and the analogue, the virtual and the real, our bodies and our laptop screens, textiles and QR codes. “Evolving Futures: Owning our Mess” culminated in the art-science co-creation of a potentially transformative, participatory intervention installed in an online exhibition on 11 May 2021.

The StartClim research programme

The StartClim climate research programme is a flexible instrument. Because of the short project duration and annual allocation of project topics, it can react quickly to topical aspects of climate and climate change. It is financed by a donor consortium:

- Austrian Federal Ministry of Education, Science and Research
- Austrian Federal Ministry of Climate Action, Environment, Energy, Mobility, Innovation and Technology
- Klima- und Energiefonds
- Federal Province of Upper Austria

StartClim has been studying adaptation to climate change since 2008. Since StartClim2012, the programme's aim has been to deliver scientific contributions to the implementation of the Austrian National Adaptation Strategy.

The StartClim2020 projects examined different aspects of relevance to climate change adaptation in Austria.

The StartClim2020 report consists of an overview of the results in German and English, along with separate documentation with detailed descriptions of the individual projects by the respective project teams. All StartClim2020 reports and documents will be available for download on the StartClim website (www.startclim.at). Furthermore, a limited number of folders containing a short summary of the results will also be made available

StartClim2020.A: Norm2050: emission-reduced, climate-resilient building and living in Vienna in 2050

Modern humans spend most of their lives in a built environment. How we shape this environment has a major impact not only on our current health and well-being, but also on future living conditions. As urbanization continues, cities will take on an increasingly important role in addressing urgent climate change mitigation and adaptation issues in the future.

The built environment is subject to numerous regulations, laws and standards. These are often not adapted to future needs and climate situations, and historical weather observations are the basis for normative specifications for a building. For example, the heating and cooling requirements of buildings are calculated using temperature measurements from the period 1978 to 2007 (ÖNORM B 8110-5) instead of working with future climate scenarios.

Not only new buildings but also existing buildings are affected by climate change. This fact is significantly exacerbated by the long lifespan of real estate and renewal cycles of at least thirty years. The built environment as a living space is crucial for the well-being of the users, but it also has a great influence on climate change or the mitigation through its energy consumption and emissions.

The goal of the Norm2050 project was to analyse the numerous regulations, laws, standards and procurement guidelines for residential construction in Vienna in accordance with the goal of emission-reduced, climate-sensitive construction and living in Vienna in the year 2050, to identify obstacles and conflicts in the achievement of this goal, and to make recommendations for action. This was done with special consideration of the five building-related goals of the framework strategy “Smart City Wien 2019 to 2050”. For that purpose, the three topics “Interior, comfort and energy”, “Urban climate and exterior” and “Health and building materials” were analysed and recommendations made.

Interior, comfort, and energy

The updating of the climate datasets used as a normative basis for the calculation of building qualities was identified as particularly relevant. For example, the heating and cooling requirements of buildings are based on temperature measurements from 1978 to 2007 (ÖNORM B 8110-5). Only if the climate is realistically represented in the calculations, can an emission-optimized and climate-sensitive building be constructed.

The heat supply of buildings should be fossil-free in the long term and should already be considered in new buildings and renovations. Current legislation, such as the Wiener Bauordnung (Vienna Building Code), must be adapted accordingly. Support initiatives such as “Raus aus Gas” and “Raus aus Öl” will facilitate the changeover.

Because of climate change, a decreasing demand for heating and an increasing demand for cooling can be expected. Consequently, the cooling of buildings is gaining importance. For that reason, heating and cooling need to be considered and described together. A reasonable room temperature could be based on adaptive comfort models as a function of the outside temperature and without additional active cooling. National laws, standards or guidelines need to be adapted accordingly.

Urban climate and outdoor space

It is important outdoors to counteract the development of urban heat islands through targeted measures. The urban climate analysis map of Vienna (Stadtklimaanalysekarte) could make a valuable contribution to improving the urban climate by keeping fresh-air corridors free and by cooling at night. Such maps could be included in ÖNORM B 8110, the Wiener Bauordnung and the new OIB Guideline 7. Furthermore, landscape protection areas could be designated in the urban climate analysis map of Vienna and the Wiener Naturschutzgesetz (Vienna Nature Conservation Law).

Regarding climate-sensitive zoning, the Wiener Bauordnung should address the preservation or creation of environmental conditions that ensure a healthy basis for life and that promote the careful

use of land and energy resources. The Wiener Garagengesetz (Vienna Garage Law) should prohibit development of open spaces for the construction of new garages. Likewise, the underbuilding of open spaces for the construction of new garages should be regulated. Alternatively, at least minimum structure thicknesses should be defined.

The preservation and creation of infiltratable areas should also be considered. This could be implemented in the Wiener Bauordnung, Wiener Gehsteigverordnung (Vienna Pavement Regulation) and the Wiener Kanalanlagen und Einmündungsgebührengesetz (Vienna Sewage System and Connection Law). Under certain conditions, adjacent or public areas could be infiltrated. In the future, the recirculation of precipitation water should be prescribed by law. OIB RL 3 could be used as a basis for this.

Health and building materials

In the future, all materials used should also be selected from the perspective of resource conservation. This includes transport routes. Demolition or excavation material on site should be reused. Legal regulations are required, for example based on a new guideline on sustainability issued by the Austrian Institute of Construction Engineering (OIB RL 7 for sustainability). The reusability, recyclability and disposability of materials, which up to now has mainly been covered by the life cycle assessments, should in future be considered from the outset in planning processes.

Specific recommendations for renewable raw materials (linoleum, wood, etc.) or a (at least gradual) exclusion of fossil plastic products (rubber, PVC-free plastics, etc.) should be included in the Raumbuch Wien and in the Ökokauf Wien criteria. The same applies to insulation materials. It is also proposed that a minimum amount of recycled material (e.g. gypsum from old gypsum plasterboards for new gypsum plasterboards) be prescribed for the Ökokauf Wien criteria for finishing boards (No. 08007). This should be implemented in a step-by-step plan with a long-term perspective. At present, there is no such requirement. In the criteria for textile floor coverings (No. 08003), a take-back guarantee by the manufacturer should be required, and complete recycling – i.e. clear separation of the different parts of the carpet (wear layer and backing layer) – should be traceable. For carpets with glued (bitumen) backing this is not the case. Leading carpet manufacturers have been offering such products for several years.

It is recommended that deconstruction and recycling concepts and a material building passes be made mandatory when planning renovation projects, but especially for new buildings. Guidance can be provided by building assessment systems and certifications, such as “klimaaktiv”, the Gesellschaft für Nachhaltiges Bauen (ÖGNB) or the Österreichische Gesellschaft für Nachhaltige Immobilienwirtschaft (ÖGNI). In addition, a legal regulation is needed, for example based on a new OIB RL 7 for sustainability.

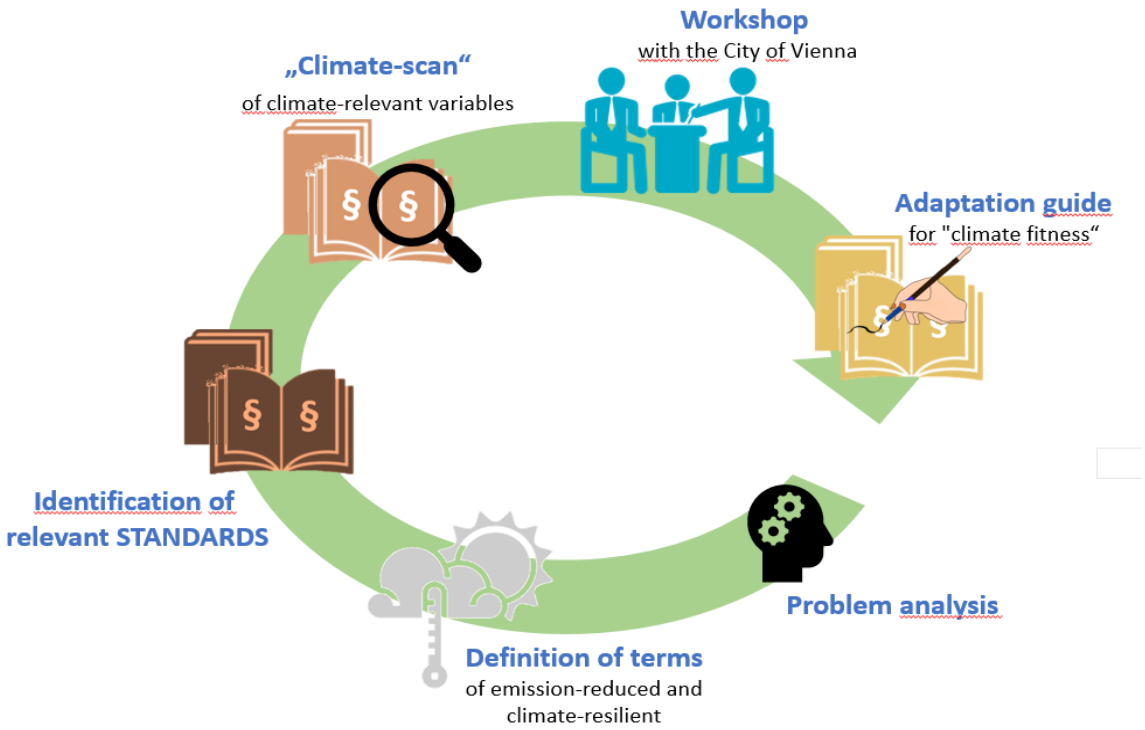

Fig. 1: Norm2050 flow diagram

StartClim2020.B: Why we fail to tackle climate change: exploring barriers to pro-environmental decision-making in the lab and field

Achieving the global climate goals requires not only political action and technical innovations, but also long-term adaptation of individual behaviour. While knowledge and awareness of the consequences of climate change are growing among the majority of the European population, behavioural patterns in the field of nutrition, mobility or consumer behaviour, for example, are changing only slowly. As a consequence, despite a slight decrease in recent years, Austria's per capita emission levels of 8.95 tonnes of CO_2 equivalents are still above the country's target values, in particular because of a significant increase in greenhouse gas emissions in the traffic and transport sector since 1990.

This project addressed the question of why, despite increasing awareness and knowledge, the levels of environmentally and climate-friendly behaviour continue to be low among the population. The underlying causes of this discrepancy between awareness and actual behaviour – referred to in the literature as the **value-action gap** – are multifaceted. The project explored three behavioural barriers that can impede the transfer of pro-environmental attitudes into corresponding actions and thus counteract sustainable behavioural change.

(1) Lack of immediacy: The effects of environmental behaviour usually affect others and only become apparent with a time lag.

(2) High uncertainty: the consequences of environmental decisions are often perceived as uncertain.

(3) Marginality: the contribution of individual behaviour to the prevention of environmental and climate impacts is often perceived as minor.

These three behavioural barriers can increase the psychological distance between decisions and the resulting consequences, thus contributing to failure to act on attitudes and values.

This project investigated the role of the three barriers (lack of immediacy, uncertainty, and marginality) in environmental behaviour using experimental methods in an online laboratory experiment (N=802 participants*) and a field experiment (N=652). In the laboratory experiment, subjects played a climate change game, interacting in groups under the incentive structure of an ecological dilemma. For this purpose, they could repeatedly invest in a group project that preserved the ecological common good but which became less effective if the joint contributions did not exceed a certain threshold. Climate-friendly action was thereby conceptualized, as a decision that promoted the ecological common good, even if it came at an individual cost. The three barriers were varied between interaction groups, allowing inferences to be made about the causal effects.

In the field experiment, subjects were invited to participate in a vignette study two months after the laboratory experiment. In this study they had to decide whether to donate an amount to actual environmental forestation projects or to keep it for themselves. In the descriptions of the environmental projects, we again varied the individual behavioural barriers in terms of a) personal benefit from donating to the environmental project (immediacy), b) the likelihood of tree survival at each project site (uncertainty), and c) the relative importance of the individual contribution to the project (marginality). The variation allowed us to examine how the respective behavioural barriers affected the willingness to donate and thus environmental behaviour. With the combination of laboratory and field experiments we were able to identify the causal influence of the three barriers while controlling for contextual third variables in the laboratory setting and to validate the results in a real-world decision scenario in the field experiment.

The study results show a clear influence of the **three behavioural barriers on environmental decision-making** and the individual value-action gap. In the climate game, the subjects found it more difficult to translate their own environmental values into actions as the number of barriers increased. The value-action gap increased when people were not affected by the consequences of their own actions (lack of immediacy), when the extent to which their contribution supported climate protection was uncertain

(uncertainty), and when the impact of their contribution was considered to be only small (marginality). The field experiment confirmed the influence of two of the three behavioural barriers. Also in this study, the value-action gap increased when there was uncertainty related to the consequences of actions and when people were not affected directly. Together, the laboratory and field studies showed the influence of the three behavioural barriers on decision-making processes, providing valuable insights into the obstacles and problems specific groups of people face in adapting to sustainable behaviour.

These insights could be used to design effective environmental policies and thus help overcome the multiple challenges in transforming behaviour. Of particular importance here is the field of climate communication, which could help bridge the psychological distance in environmental decision-making and reduce issues related to high uncertainty and lack of immediacy. In order to effectively counter the climate crisis, it is important to talk about climatic changes and their causes. In this context, it is particularly important to choose a form of communication that is as simple as possible, that reduces the abstractness of climate change, and that clearly emphasizes the possible consequences, including consequences for the individual, thereby offering ways for people to translate their values into actions is another key element of a successful communication strategy.

In the field of education and civil society engagement, there are also many entry points that could help improve perception of environmental and climate issues and the importance of individual behaviour. It is important to integrate climate and environmental education more intensively into everyday school life, with a focus not only on imparting knowledge but also on raising awareness. Educational programmes and initiatives should address broad segments of the population in order to achieve a high level of inclusiveness.

To be successful, measures should be embedded in a **supportive environmental and climate policy framework**. Institutional and structural conditions need to be created to reduce behavioural barriers. These could be supplemented by financial and non-financial incentives to encourage people in their environmental behaviour. In addition to incentives, bans or prohibitions, and the creation of suitable framework conditions, nudges are another policy tool that could be used to encourage environmental behaviour. It is important to promote holistic measures that cover different areas and involve multiple stakeholders. The findings of this study could help overcome the manifold challenges in transforming behavioural patterns and thus support efforts to achieving more sustainable societies.

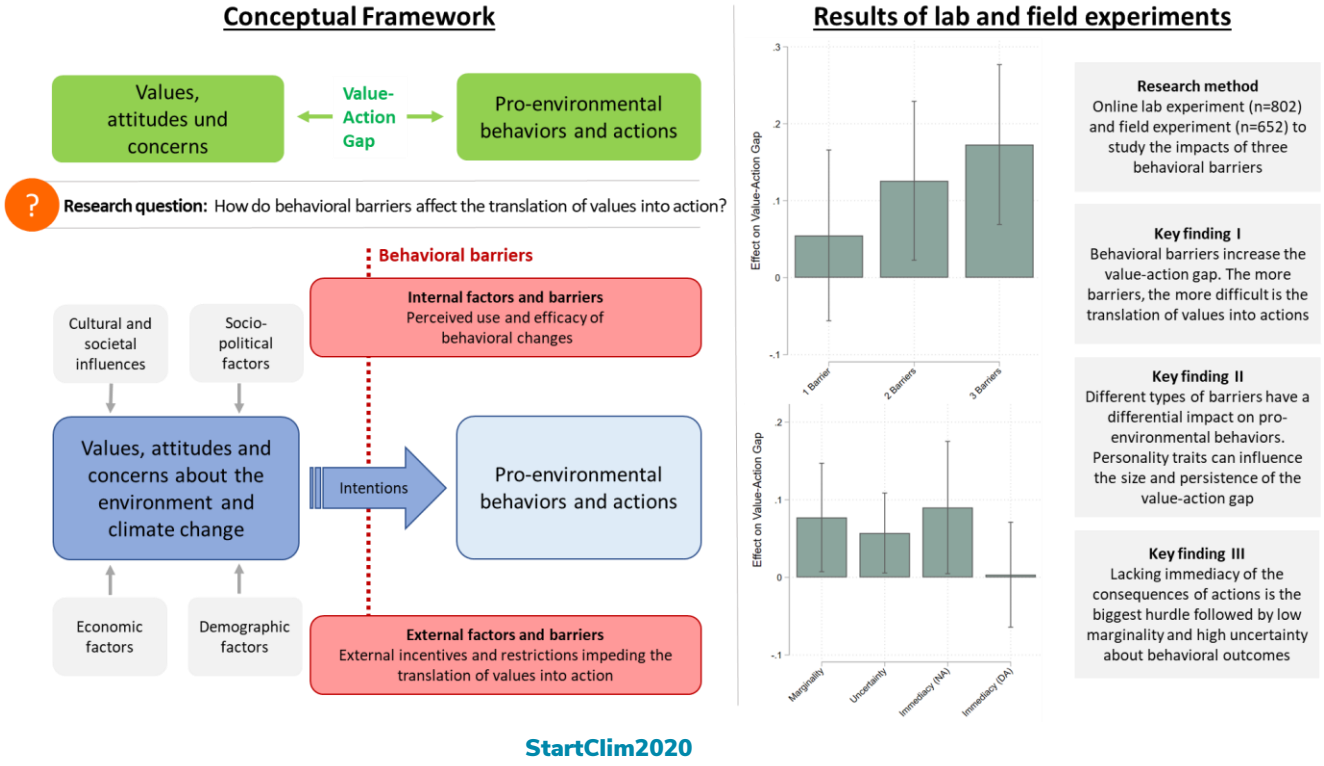

Fig. 2: Project findings

StartClim2020.C: BELONGevity: innovations for a socially inclusive and sustainable circular economy

Most material goods today, once produced and sold, progressively lose value until they are considered waste and disposed of. In a circular economy, on the other hand, the life of material goods would be organized so that they can be kept in circulation for as long as possible. The transition to a circular economy could thus significantly reduce resource consumption and make an important contribution to challenges such as climate and ecosystem protection. However, while the circular economy is now firmly anchored in political discourse, its implementation remains a major challenge.

This project addressed the question of how a transformation to a circular economy could succeed in a world of diverse needs and divergent ideas of a good life. In the current discourse on the transition to a circular economy, such differences receive little attention. Rather, the main issue is seen as how to increase public acceptance for predetermined circular strategies and how to enable access for all. The focus so far has thus been on the implementation of environmental policy measures and the promotion of innovative business models. It is assumed that a dematerialization of the economy would benefit all people equally and is therefore universally desirable. The extent to which this assumption is correct has significant implications for the possibilities and limits of a transformation.

Against this background, this project set out to analyse the current approach to transformation from a social inclusion perspective and to develop building blocks for an alternative, more promising approach. The project was guided by the following questions:

- What characterizes socially inclusive provisioning structures in a circular economy?
- To what extent can a socially inclusive design of provisioning structures contribute to an increase in resource efficiency?
- How can policy support the development of more circular and socially inclusive provisioning structures?

To gain a better understanding of the importance of social inclusion for the transformation to a circular economy, the project gathered insights from various actors. In addition to interviews with eleven circular providers and ten households, two workshops were held with experts and stakeholders. Taken together, the data gave rich insights into current challenges in developing a socially inclusive circular economy and the strategies pursued.

How does a socially inclusive circular economy create?

The analysis showed that, in addition to increasing resource efficiency, a circular economy can contribute to well-being in many ways by facilitating the conditions for better material participation. For example, longer-lasting goods can provide financial relief, and creative activities such as upcycling or recycling can help build self-efficacy. However, the extent to which a double dividend in terms of the simultaneous increase in resource efficiency and in individual well-being can be achieved depends crucially on the added value created.

A social inclusion perspective recognizes that there are multiple legitimate material needs. In this project, four needs or forms of material participation were distinguished, which served as a starting point for further analysis:

- **Using:** Access to essential necessities
- **Investing:** Access to asset goods for the fulfilment of future needs
- **Producing:** Autonomous creation of products
- **Consuming:** Autonomous selection of consumer goods

Such a multidimensional approach to the meaning of material participation emphasizes that materials play essential roles in allowing a good life going far beyond consumption. At the same time, it also rejects positions that see a transition to a post-materialist way of life oriented towards access to goods ("using instead of owning") as the best solution for all. Rather, as figure 1 illustrates, and contrary to efforts at hierarchization (e.g. waste hierarchy), a broad repertoire of parallel strategies for increasing resource efficiency is needed to address these different forms of material participation.

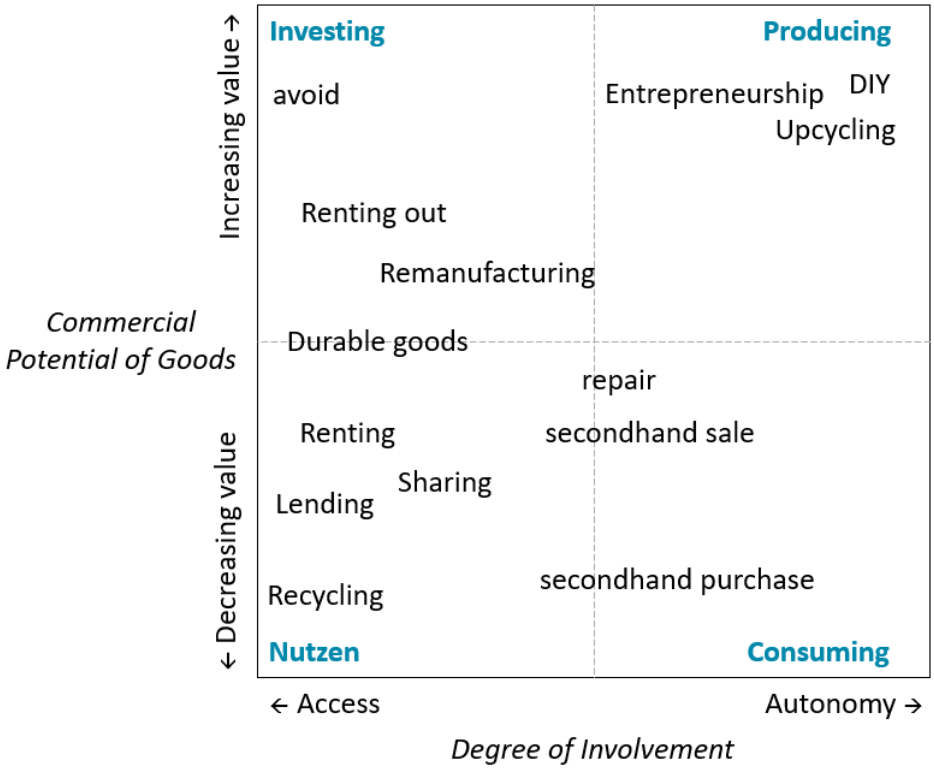

Fig. 3: Potential of circular strategies for facilitating material participation

How inclusive are existing circular provisioning structures?

The opportunities for taking advantage of these different potential benefits of a circular economy differ considerably depending on the socio-economic background. One major reason for this can be seen in the specific requirements of many circular models, which place high demands on product quality. In many cases, as in the case of loan offers or repairs, this is a basic prerequisite for their functioning. Yet this is often accompanied by increased financial insecurity and greater hurdles to affordability for households. The time and physical effort associated with many circular practices also play a significant role.

Furthermore, very different approaches to dealing with diversity in society can be identified, each with different implications for the composition of the groups reached. For example, people from the post-materialist milieu, who have a relatively high income and show great interest, represent a particularly attractive and easy-to-reach target group, especially for innovative start-ups with a strong focus on the circular economy. In fact, providers have a strong intrinsic momentum in this regard, where social media, word of mouth and reporting in relevant magazines can almost single-handedly develop a large demand from this milieu. However, processes of appropriation mean that other target groups can be inhibited from taking part.

Against this backdrop, the analysis questioned the sometimes unequal handling of diversity among providers in relation to staff on the one hand and target groups on the other. While persons from diverse backgrounds are proactively sought and selected as staff, efforts to reach diverse target groups rarely go beyond a passive and financially deficient open-door approach. At the same time, ecological

distinction – and thus mutual exclusion – can be reinforced, albeit unintentionally, by designing provisioning structures to suit the post-materialist milieu.

What can be done to make circular provisioning structures more socially inclusive?

From the perspective of social inclusion, a transformation to a circular economy requires the design of supply structures along several dimensions:

1) The mobilization of a broad repertoire of different resource efficiency strategies;

2) The realization of economies of scale and scope to create barrier-free access;

3) A proactive approach of reaching out to disadvantaged individuals and groups.

Organizations and companies can make a significant contribution to social inclusion by pursuing these strategies, while ensuring that transformation does not stop after reaching already privileged social groups. As the report shows, promising approaches can already be observed among existing providers. The report also discusses the potential of pushing for more strategic networks and partnerships between organizations from different backgrounds. To resolve the conflict for companies and especially start-ups between addressing particularly easy-to-reach target groups and a more socially inclusive approach, there is a need for financial support and awareness-raising among company founders in the preparation and start-up phase.

StartClim2020.D: Impact of different management on water and carbon/nitrogen fluxes in inner-alpine grassland

The total agricultural area in Austria amounts to 2,655,565 ha. Of this, 1,328,871 ha is arable land and 1,258,809 ha is permanent grassland. The latter breaks down into meadows with one cut per year, meadows with two cuts per year, meadows with three cuts per year, mountain meadows, litter meadows, and the abandonment of grassland. Grasses cut once a year cover an area of 31,123 ha, grasses with two cuts per year 229,349 ha and grasses with three and more cuts per year 483,374 ha (bmlrt.gv.at, 2021). At higher (above montane) altitudes, the management with **two cuts per year is dominant because of climatic conditions**. The cutting dates and the resulting grassland yields are highly dependent on the weather conditions. The first cutting in these regions usually takes place around the middle of June. The air temperatures in Austria have increased up to 2°C since beginning of the twentieth century, and the annual precipitation has increased on average by 11 per cent. Forecasts suggest a small increase in precipitation, particularly in the northwest of Austria. Through the combination of constant precipitation and an increase in air temperatures in areas north of the Main Alpine Ridge, the growing season could become longer. Thus, grassland yields could possibly benefit from the altered climate conditions. Through the high precipitation rates and warm growing season in 2020 (average precipitation amount from April to October 952.7 mm, average air temperature from April to October 10.8°C) the permanent grassland with two cuts per year at an altitude of 1,014 m (Oppenberg, Styria, Austria) achieved high grassland yields, which provided the entire ground food (basis yield) for the farm's livestock (cows) for the upcoming year 2021. The ideal growing conditions in this grassland location in the growing season in 2020 can be explained in addition by the high soil water availability, which can be calculated from the soil water balance (precipitation measured – grass-reference evapotranspiration calculated (after Allen et al., 1998) – seepage water measured) and from the high matrix potential in this growing season (fig. 4).

Because of the favourable weather and wet soil conditions, high grassland yields (grass silage and hay) from end of August to end of October and very high yield aftermath grazing in autumn were recorded. Furthermore because of the high biomass yields until autumn, the aftermath grazing could not be totally grazed by the cows. The valuable late summer forage in the autumn was therefore used as green fodder (cut grass) for the livestock on the farm.

The observations in the year 2020 showed that under such weather conditions (high precipitation connected with high air temperatures in the growing season) a three-cut management regime is feasible instead of a two-cut regime with aftermath grazing.

In the light of this hypothesis, more intensive management of **three cuts per year** will be practised in the 2021 growing period on this grassland site. The site is equipped with seepage water collectors, soil sensors for measuring the soil water content as well matrix potential at different depths of an area of 250 m². To avoid adverse effects on biodiversity through more intense grassland management, flowering strips were sown on the farm.

In contrast to 2020, when the spring was very dry, spring 2021 showed very high precipitation. Furthermore, intensive winter precipitation in the form of snow occurred even at the end of February and continued until the end of April 2021. In these months (from 25 February to 16 April), continuous snow cover of > 10 cm was recorded on 26 days. From 13 to 16 April snow cover of more than 30 cm was measured.

Besides the high snow precipitation in spring 2021, the air temperatures in spring were below the level of 2020 (average air temperature from March to May 2020 was 5.6°C compared with 3.3°C from March to May 2021).

Because of the high precipitation and low air temperatures until June 2021, the first cut at the three-cut test field had to be postponed for about seven days (planned about 31 May to 2 June) and was in fact completed on 8 June.

On that day, directly before the first cut, a **detailed vegetation survey** was carried out for both management systems (two- and three-cut), which confirmed that the grassland site is representative.

The two- and three-cut test site recorded high vegetation cover of 95% and 90%, respectively. In the first growth, the dominant species were grasses, accounting for 50% and 45% of the vegetation, respectively. Herbs had a high component (35% and 40%). Leguminose species accounted for the remaining 15%. The dominant species on both test sites were *Trisetum flavescens*, *Ranunculus repens*, *Alchemilla monticula*, *Achillea millefolium*, *Ranunculus acris* and *Poa trivalis*. On the three-cut site *Dactylis glomerate* and *Rumex acetosa* were also noted.

A metal frame (1m x 1 m) was placed at On three different points in the test field area and the plant composition crop, height (cm) and vegetation cover (%) were estimated.

At the two- and three-cut test sites, high vegetation cover of 95% and 90% was recorded. The dominant species in the initial growth were grasses with a component of 50% and 45%, respectively. Herbs accounted for 35% and 40% and legumes 15% on both test sites. The dominant species on both test sites were *Trisetum flavescens*, *Ranunculus repens*, *Alchemilla monticula*, *Achillea millefolium*, *Poa trivalis*, *Ranunculus acris* and *Poa trivalis*. On the three-cut test site *Dactylis glomerate* and *Rumex acetosa* were also noted as main components.

A metal frame (1m x 1 m) was placed at three different points in the test field area and within this frame the plant composition, crop height (cm) and vegetation cover (%) were estimated. The percentage areas of the grass, herb and legume species were also estimated within the frame after Schechtner (1958).

To determine the biomass, the plants were manually cut to 5 cm using hedge shears and subsequently weighed. 600 g of the cut grass biomass was brought to AREC Raumberg-Gumpenstein for analysis of the dry matter yield and forage quality. The biomass sample was dried for 48 hours at 55°C and afterwards analysed gravimetrically using a precision scale for dry matter yield (g/kg fresh matter). The raw nutrients, cell wall components and bulk elements (phosphorus, potassium, magnesium, calcium in g/kg dry matter [DM]) and the trace elements (sodium, iron, manganese, zinc and copper in mg/kg DM) were also measured. The fully cut fresh matter was brought afterwards to the cows grazing on the meadow.

The mown area was fertilized with liquid slurry from the farm itself two days after the cuts. Around 1.2 l/m² = 10.2 m³/ha were manually fertilized with a watering can. The subsequent precipitation was almost ideal for infiltration into the soil, giving a good start for the following plant growth. The seepage water was filled in sampling bottles before and after fertilization to quantify cation and anion concentrations.

The two-cut test site was cut for the first time on 18 June, ten days after the first cut of the three-cut site (fig. 5). This was relatively early compared with the usual cutting dates, as the stable, high-pressure weather conditions from 14 to 19 June were favourable for cutting . Apart from silage management on the observed grassland farm, it was also decided to cut the hay on the surrounding grassland field. The biomass samples for the first cut on the two-cut site were analysed in the same way as described above. Because of the continued stable high-pressure weather without any significant precipitation after the cut, fertilization with 2 l/m² (20m³/ha) liquid slurry from the farm was not possible until seven days later. The more intensive fertilization compared with the fertilization of the three-cut site was due to the use of a tractor-driven machine. The 125 m² three-cut site had to be fertilized manually because of the adjacent extensive management area. The following one and two cuts and fertilization and sampling (biomass, seepage water before/after fertilization, plant survey) will be carried out, depending on the weather conditions, from late July/mid-August and early September. The grassland yields and nutrient flux, forage quality and associated soil water balance and seepage water analysis will be compared and discussed. The results will help farmers in these areas to improve the quality and obtain the best possible biomass yield.

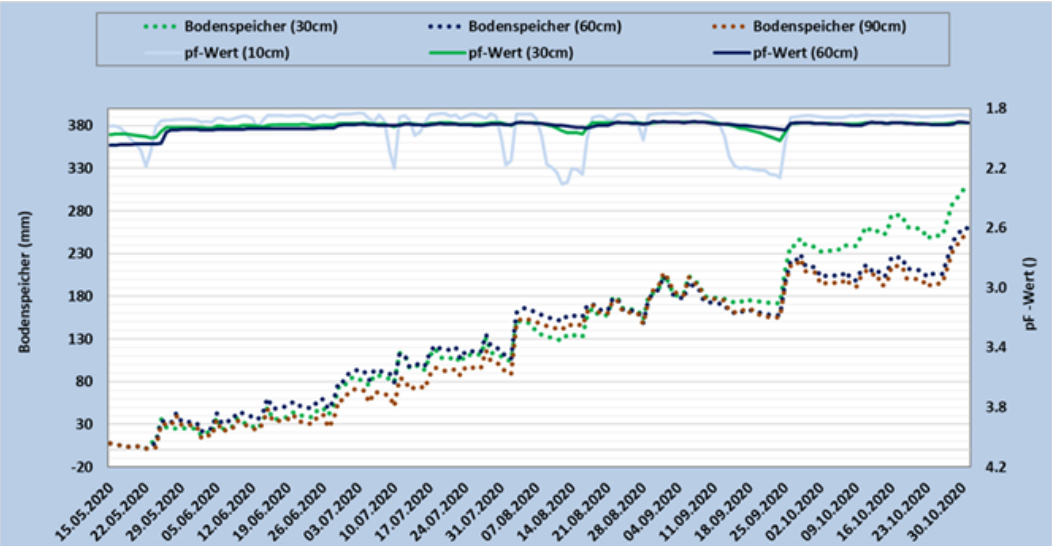

Fig. 4: Daily matrix potentials (pF values) and cumulative soil water storage on the grassland test site at Oppenberg (Styria, Austria, 1,014 m altitude) from 12 May to 31 October 2020

Fig. 5: Management of the two-cut test site on 18 June 2021 and surrounding grassland field. The six wooden pegs mark the seepage water collectors at depths of 30 cm, 60 cm and 90 cm in the two management areas (two- and three-cut sites).

StartClim2020.E: Quantification of land use change and its consequences for soil carbon storage

In Austria, annual land take of agricultural land for other purposes is high. Agricultural soils fulfil several functions and are **enormous carbon sinks**. We know little about how and whether the national target of 2.5 ha are known or implemented at regional and local levels. In this study, we quantified the actual **losses of agricultural soils** since 1975 in seven communities and calculated the amounts of soil carbon affected by land use change. We also conducted twelve qualitative interviews with fourteen local decision-makers and regional/national stakeholders to understand the losses and obtain arguments for and against land use.

The studied municipalities lost between 2.1 and 15.5 ha of agricultural land per year.

Since the 1970s, between 4 and 42% of former agricultural soil has been converted in the respective municipalities. We found the highest losses in two municipalities that have had a steadily growing population for decades and the highest rate of abandoned farms. They are both typical examples of structurally strong communities in urban agglomeration areas with high population growth, high settlement pressure and an attractive job market either locally or in the immediate vicinity.

Fig. 6: Two landscape-shaping land uses in Hainfeld, Lower Austria (©Kapelari 2020)

Since more former cropland than grassland soils have been affected by the land use changes, less of the soil carbon stocks was affected by the conversion (4-40%). There is no clear pattern in the studied communities as to whether more low-value (shallow, stony. moist;) or high-value (deep, nutrient-rich, easy to crop;) agricultural soils are affected by the land use changes.

From the expert interviews we learned that housing, commercial use and infrastructure are the **most important reasons for soil consumption**. The fact that agricultural soils are valued according to their production function was new to the decision-makers. The need for land for housing, businesses and (municipal) infrastructure was seen by local respondents as a natural development. For many, the direct and indirect costs of land consumption were important arguments for reducing the loss. Among the indirect consequences, social degradation and social conflicts were highlighted by several interviewees.

The agricultural soils in Austria are supposed to cover many needs, and there are **conflicts of use** between manufacturing, habitat, flood protection and the function of agricultural soils as sites for settlements, businesses and infrastructure. Studies like this that quantify soil loss and attempt to put it in context provide a good basis for discussion. Unfortunately, there is a tradition in Austria of amending supra-local development concepts on an ad hoc basis. As a recommendation to all political decision-makers, we suggest that they – i.e. federal, provincial and municipal authorities and their representatives – make a joint effort to define a binding reduction target. Furthermore, the **spatial**

planning instruments that we already have in Austria must be used consistently. In spatial planning, the soil value in relation to the soil functions should be taken into account more in the site assessment.

StartClim2020.F: Development of a method to measure the contribution of cover crops to carbon accumulation in agricultural soils

Humus balancing is a tool that enables farmers to calculate for themselves how their management affects the humus content of their soils and, accordingly, to adapt their **crop rotation and management** practices themselves through **humus-enhancing measures** such as the addition of organic fertilizers or cover crops so as to maintain or increase the humus content of their soils. STAND, a site-adapted humus balance method, was developed and statistically validated using a database of 330 variants from long-term field trials from all over Europe. In Austria, more than 1,100 participants in Bio Forschung Austria's (BFA) humus balance seminars use this method for their farms.

The **effect of cover crops on humus enrichment** is **estimated** by humus balancing methods **as being relatively low**. This could be due to the fact that the humification coefficients are based on data representing conditions in decades-old long-term field trials. However, cover crop cultivation has seen major progress in Austria in the last twenty years. Cover crop mixtures with up to fifteen species have replaced the previously customary mustard cover crops, and biomass yields of 20 to 100 t fresh mass per hectare have become common.

In order to verify the humification coefficients of cover crops and to better assess the contribution of cover crops to humus enrichment, Bio Forschung Austria's own results of twelve years of cover crops trials were evaluated. For comparison, older literature on cover crops trials cited by Kolbe in connection with humus balancing and the current meta-studies on soil carbon sequestration with cover crops and the literature cited therein were evaluated.

BFA's own data on above-ground cover crop biomass (350 experimental treatments) showed a mean of 2,534 kg/ha DM (dry matter) and a median of 2,223 kg/ha DM, ranging from 200 kg/ha to almost 8,200 kg/ha DM. There was a significant difference between cover crops in the dry region of eastern Austria, which averaged about 2,300 kg/ha DM, and those in areas with higher precipitation, which had a mean biomass of about 3,800 kg/ha DM.

The longer growing season available to overwintering cover crops was reflected in a mean biomass of 4,300 kg/ha DM (across all sites), while frost-killed cover crops only achieved a biomass of about 2,350 kg/ha DM when sampled in October.

Amounts of biomass measured in our own trials agree well with data from other Austrian cover crops trials, with cover crop mixtures achieving higher fresh and dry matter yields on average than cover crops consisting of a single plant species. This is due to better utilization of light, water, nutrients, etc. by the mixtures. Also, feeble development of one mixture partner can be compensated by the other plants in the mixture.

In the older literature on humus balancing, biomasses averaging around 2,100 kg/ha DM were reported for frost-killed cover crops. For hardy cover crops, the mean was 4,430 kg/ha DM.

For the cover crop treatment data used above ground, the biomass averaged 3,150 kg/ha DM for frost-killed cover crops and 4,200 kg/ha DM for hardy cover crops. This data includes sites with different soil types, tillage and climate, and cover crops consisting of only one plant species and of cover crop mixtures.

Because of the difficulty in obtaining root biomass, studies of cover crops root biomass are much rarer than studies reporting above-ground biomass data.

Thirty **root biomass** datasets were available from BFA's own cover crop trials, mostly frost-killed cover crop mixtures containing legumes. The average root biomass was 1,690 kg/ha DM, with a range from 500 kg/ha to about 4,000 kg/ha DM. The range agrees well with reports from other Austrian cover crop trials and recent literature. Only a few studies in the older literature on humus balancing report root

biomass. In these studies, the root biomass of frost-killed cover crops was 927 kg/ha DM on average, which is by far lower than the amount measured in the BFA trials.

Fig. 7: Cover crops and root biomass

Cover crops and their roots boost microbial biomass, which today is considered to be the **most important source of soil organic matter**. For this reason, it is relevant that higher root biomasses have been measured in BFA's trials and in recent literature.

Summing up, the results provide evidence of a **selective need for revision of the humification coefficients** of cover crops in the **site-adapted humus balance method**. After discussion (online) with Dr. Kolbe, however, additional evaluations of more recent long-time field experiments are still necessary for confirmation.

It is undisputed that cover crops can make a significant contribution to humus enrichment and carbon storage on arable land. The site-adapted humus balance method quantifies the contribution of cover crops on site types ("site groups") 1 to 5 with 120–370 kg humus C /ha/a for hardy cover crops and 80–330 kg humus-C /ha/a for frost-killed cover crops. On site type 6, which includes soils with a very high soil organic matter decay rate, a humus depletion of -20 kg humus C /ha/a for hardy cover crops and of -60 kg humus C /ha/a for frost-killed cover crops is expected on account of the priming effect. Depending on the amount of aboveground cover crop biomass, a second, usually smaller, positive humus C contribution is added.

The recent meta-studies on soil carbon sequestration with cover crops give **much higher values for carbon sequestration**, a total of 139 evaluated treatments from 47 different trials on sites with different soil types, tillage and climate, and calculated an average increase in soil carbon content of 490 kg C /ha/yr.

In addition to the effect of increasing soil carbon content, cover cropping or intercropping has numerous other positive effects that are important for climate change adaptation.

The supply of organic matter by the above- and below-ground cover crop biomass feeds soil life. Root exudates **stimulate biological activity in the soil and mobilize nutrients**, increasing soil fertility. Active soil microorganisms, fungi and roots aggregate soil particles through their excretions, thus increasing aggregate stability and improving soil structure. The improved soil structure increases the infiltration rate and the water storage capacity of the soil, which is a great advantage with the higher number of dry phases and heavy rain events expected as a result of climate change. Soil cover and root networks, as well as the more stable aggregates, protect the soil from silting and erosion. Improved soil structure also facilitates subsequent crop rooting and makes tillage easier, which results in lower fuel requirement and CO_2 emissions.

The longer a cover crop is standing in the field, the more above-ground biomass, but more importantly, the more root biomass it can form, which is essential for humus enrichment. Most of the positive effects of cover crops, both for increased humus enrichment and groundwater and erosion protection and climate change adaptation, increase with the duration of the cover crop. Therefore, it would make sense to move away from the fixed cut-off dates for the financial support of cover crops in the Austrian ÖPUL agri-environmental programme and to make support of the cover crop duration more flexible, with online registration and deregistration.

StartClim2020.G: "Homo sanus in caeli sano – a healthy person in a healthy climate": potential synergies between health policy and climate policy (HICS)

This study looked at the **climate protection and public health concerns that have the greatest potential for consensus among relevant actors in Styria**. We investigated the visions for a future climate-friendly society articulated by relevant actors, and the way these visions relate to climate protection and public health goals. We also analysed the fields of action that could be conducive to creating new political and strategic alliances aimed at a climate-friendly and healthy society.

Based on interviews with **fifteen actors in the field of climate change and six public health actors** (n=21), who are mostly active in Styria, three visions for a future climate-friendly and healthy society were distinguished. These visions may also be relevant for other regional stakeholder groups in Austria. The first type, **"spatial planning for life quality"**, is part of the overarching discourse on sustainability. The local variant of this discourse identified in the interviews focused on urban planning interventions. The second type, "**sufficiency and change of consciousness**", is part of the overarching discourse on a fundamental social ecological transformation. The local variant in the interviews revealed a systemic change of consumption, behaviour and lifestyle in combination with moral reorientation and a holistic promotion of health. The third type, **"degrowth"**, mainly addresses the political change in societal relations. It is also part of an overarching discourse on transformation. Almost all of the health actors belonged to the third type, "degrowth". **Mobility was one of the core topics** regarded consistently as important across all visions. Policies for a climate-friendly and healthy society that were supported, suggested or demanded by the interviewees could be differentiated primarily on the basis of their specific institutional context, which went along with certain strategic emphases. Thus, NGO representatives mostly supported actionist policies for societal change in the form of a **"change in participation"**. By contrast, almost all health actors focused on support of active mobility – a topic that links health, urban space, life quality and climate protection – in the form of a **"change in mobility"**. A third group of policies that we call **"change in energy"** was personified by three representatives of public agency planning departments. This group emphasized communication, participation and awareness raising as a means of reducing greenhouse gas emissions.

These results demonstrate that the vision of **"degrowth" has the greatest potential** for joint discourse by climate and health actors. This conclusion is further supported by the results of the breakdown of actors as a function of types of policies. In that regard, it is even clearer that most actors focused on policies addressing a change in everyday routines and lifestyle, in particular with regard to active mobility. In general, the differences between actors with respect to types of policies can be interpreted as a strategic division of labour between actionist approaches and societal demands (mostly represented by NGOs), politicization of everyday life and lifestyle (which was supported by almost all health actors), and planning-oriented approaches (most prevalent in planning departments).

Our results therefore indicate that underlining **everyday life quality** might be an effective way of enhancing the legitimacy of climate protection through increased emphasis on health aspects. In that regard, many actors in the fields of both climate change and public health included a broad range of topics, from education to work conditions or social policy innovations such as the introduction of an unconditional basic income. This result from the interviews and from the consequent workshop suggests that **many actors did not strictly distinguish between adaptation to and mitigation of climate change**. This makes an evidence-based approach to political strategy more difficult, because health impacts have to be assessed in a differentiated way. It is also particularly difficult to assess the public health impact of policies (in contrast to political goals) because of the complexity of the impacts and the lack of regional studies. On the other hand, this observation may indicate that in public debate, precise scientific evidence may matter less with regard to strategic issues than the discursive connection between health and climate topics. This would mean that a more positive image of climate

topics in general – which may result from the discursive connection with health promotion – may enhance the legitimacy of climate protection as well, in the sense of a "windfall effect".

If, by contrast, we focus on the available evidence regarding the connection between climate protection and public health and consider the analysis of the interviews together with and the results of the public health impact assessment of climate protection goals, active mobility and a **plant-based diet emerge as two core areas** of the intersection between climate protection and public health.

Based on the project results and in the light of evidence-based policy development, we therefore recommend that climate protection should be more often discussed in connection with active mobility and plant-based diets. At the same time, the confirmed scientific evidence of the positive impact on life quality and health can and should also be emphasized. The positive **circle between greening of urban space, reduction of motorized individual mobility and an increase in active mobility** has potential as a means of connecting climate change adaptation and mitigation based on scientific evidence. More green space reduces high temperatures, while green space in itself promotes health and life quality, while making active mobility more attractive. Moreover, a substantial increase in green space requires a reduction in individual motorized mobility. If these three components are jointly discussed and implemented, resistance to a reduction in individual motorized mobility could be more effectively addressed than with strategies that do not establish this connection discursively and based on scientific evidence.

Fig. 8: Climate-friendly future visions (in German)

StartClim2020.H: Change of scenery

From a scientific point of view, there are climate pathways that we, as a society, should feel constrained to prevent. However, it is (still) difficult to translate the meaning of this "prevention" into people's daily lives. With the project 'Tapetenwechsel' (change of scenery), we wanted to make a climate-friendly future visually and scientifically tangible by:

1. interviewing people who are considered climate pioneers in their field (companies and start-ups, education, land management, construction, mobility, lifestyles, etc.),
2. interviewing climate experts about scientifically based, desirable developments and visions,
3. extracting images from relevant publications (e.g., Austrian climate and energy strategy reference plan) that deal with the great transformation in a science-based manner.

Results

With the aid of a simplified qualitative content analysis, a total of 440 quotes were extracted from the collected material (28 interviews, books, documents) and thematically clustered.

Themes such as regionalization, changing values, a new kind of cooperative humanism and deceleration were frequently mentioned in the interviews. There was also much emphasis on the solar orientation of the energy system, new forms of mobility and an economy that operates in regenerative cycles. Other frequent themes were active citizenship and new forms of political participation.

Image content was then derived from these clusters. Since not all parts of the vision could be presented in a self-explanatory way (e.g. quotes on internal attitudes or on social practices and innovations), an accompanying text was written to clarify and complement the 'Zukunftstapete' (future scenario).

Future scenario ('Zukunftstapete')

Selected, frequent quotes (e.g. "small and slow solutions", "diversity as tool for resilience", "solar century", "more music and dancing", "improved quality of life", "low tech and self-empowerment", "bicycle speedways") were combined into coherent scenes (e.g. scene 11: "Celebrating diversity: Slow Music Festival", fig. 1).

These scenes formed the basis for the graphic design. All of the scenes were allocated a place in the scenario. The detailed scenes (bubbles in the wallpaper) were designed to display the essential features of the data collected. A written profile was elaborated for all detailed scenes to support the graphic implementation.

Fig. 9: Example of a detailed scene: "Celebrating diversity - Slow Music Festival" (left) and scheme of the graphical concept of the wallpaper" (right).

Graphic design

Each written profile was translated into a digital image (see fig. 1). All images were then amalgamated in an overall arrangement, the final graphic of the 'Zukunftstapete' scenario. Different topics (mobility, agriculture, city centre, villages, forest, energy, etc.) are shown in designated areas of the background. The detailed scenes – placed in the form of bubbles in these areas – enable observers to zoom into these topics (fig. 2).

The 'Zukunftstapete' was developed in a by graphic designers and scientists together. The scenario was finalized during a two-day retreat from 2 to 4 June . A virtual stakeholder workshop on 10 June brought to light final inconsistencies, which were eliminated in the final version.

The 'Zukunftstapete' was designed and implemented as a three-fold A0 plot (300 dpi print resolution). The style conveys a notion of lightness and optimism. The colour scheme used not too flashy but also not too muted colours.

Making-of video

Selected interview partners were visited to shoot short video scenes designed to inspire and provide an insight into possible future lifestyles. Likewise, the two-day retreat, in which the final composition of the 'Zukunftstapete' was decided, was also documented via video. The videos were combined into a 10-minute making-of presentation.

Dissemination

The results and products of the project open up new scope for imagining a climate-friendly future, away from the usual debate about loss and prohibition. Added value and new qualities through change can be experienced visually through the 'Zukunftstapete' (e.g. in quality of life, health, social cohesion).

The print version of the 'Zukunftstapete' is licensed as a Creative Commons. It can be easily reproduced by plotting it in copy stores (Download: www.zukunftstapete.at) and used for local/regional (climate) events and discussions. The ‚Zukunftstapete' will also be shown at climate events (Austrian Climate Day, K3 Conference in Zurich).

StartClim2020.I: ClimArtLab

In 2020 the Konrad Lorenz Institute for Evolution and Cognitive Research (KLI) and the artECO/industry think tank created a new space for transformative and regenerative collaboration. The ClimArtLab was developed over a ten-month period. In the first phase, Guido Caniglia and Dominika Glogowski designed the project framework and selected artists by means of an open call. In the second phase, a team of artists and scientists came together to explore new ways of generating intrinsic motivation for environmentally conscious behaviour and to empower individuals and groups to deal with the complex reality of climate change. Our main goal was the collective generation of potentially transformative, participatory interventions, which were installed in an online exhibition on 11 May 2021.

The project "Evolving Futures: Owning our Mess" in the ClimArtLab arose in particular from a dissatisfaction with mainstream approaches to promoting behavioural and cultural change. The approach in both research and politics relies either on **nudging** or **scaring**. However, it is becoming increasingly clear that neither of these encourage the intrinsic motivation, **the inner changes and the transformative ability** to act that are necessary to cope with climate change. In "Evolving Futures" we aimed to develop new approaches to stimulate inner transformation in relation to climate change. We asked ourselves: How can we as individuals and as a society leave fear behind and take responsibility for the chaos we have created? How can we develop intrinsic motivation and the ability to act to address challenges related to climate change? And how can art-science interventions help to generate motivation and space for change?

To answer these questions, we brought together artists and scientists from the natural sciences (especially earth system sciences and glaciology) and social sciences and humanities (especially sustainability sciences, cognitive sciences and philosophy) in a joint learning and production process. Together we designed art-science interventions that have the potential to bring about inner transformation. The team decided to focus on interventions. An installation (HOMONEXUS) and a performance (GLACIER NEX US) explored new ways of experiencing the complex relationships that connect our lives with climate change through nexus thinking, especially from the perspective of the water-energy-food nexus. A **website** was also created to digitally present the most important processes and results in the ClimArtLab (curated by Dominika Glogowski): https://climartlab.space/about/. The final virtual exhibition (curated by Dominika Glogowski) consisted of participatory live interventions based on art-science encounters.

HOMONEXUS is a participatory **textile installation** in digital and analogue spaces by the artist Francesca Aldegani and the cognitive scientist Alejandro Villanueva. The installation includes embodied and collective access to cognition and motivation in relation to the cognitive and emotional challenges that climate change poses. It was started during the ClimArtLab workshops and finalized by Francesca Aldegani after the exhibition. We used the traditional craft of embroidery as an input for collective meditation and participatory change. The participatory aspect included a deep collaboration through the contribution of the ClimArtLab team during the months of collaboration. HOMONEXUS also calls for the involvement of the participants in the exhibition through the activity of collective embroidery using a QR code sample. The performance was accompanied by son jarocho music. This is a kind of music that is embedded in a music and dance festival (fandango) from southern Veracruz and neighbouring regions in Mexico.

GLACIER NEX US is an **embodied performance** by artist Ida-Marie Corell and glaciologist and climate researcher Lindsey Nicholson. The performance takes a critical stand and interweaves glaciology and climate sciences with topics of personal identity and zoom identity, pandemic technocracy, patriarchal chat, disruption and social change. The performance was based on an "online-only destructed identity", i.e. on a character that was originally created by a malfunction of the technical zoom filter. The destructed online identity refers to the always weak position of humans within the global society in the climate crisis. The artist embodied this identity for the duration of the project and the virtual exhibition. The performance primarily consisted of a dialogue between a glacier and a glaciologist and addressed

the existential questions: Who am I today? Who will I be tomorrow? Will I even be tomorrow? An important feature of the performance was the chanting of a mantra, which was then performed online outside the participatory experience of the exhibition. Through dialogue and mantra, topics such as climate change, pandemic withdrawal from physical engagement, patriarchy, feminism and modern humanity were linked for a safe technocracy.

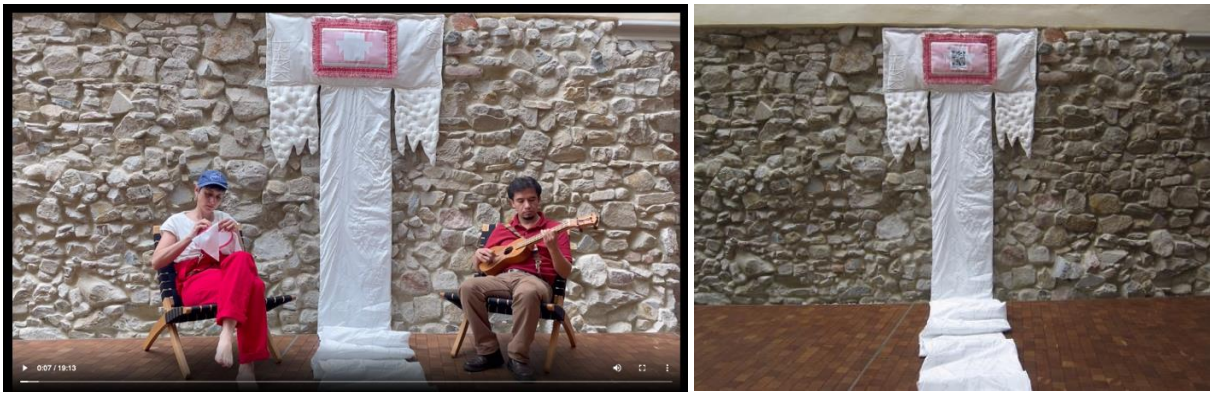

Fig. 10: HOMONEXUS, an installation by Francesca Aldegani and Alejandro Villanueva

Fig. 11: HOMO NEX US, a performance by Ida-Marie Corell and Lindsey Nicholson

Imprint

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