Start Clim 2021

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Final Report

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Contributions to StartClim2021

StartClim2021.A: iSDG_KlimAT: An SDG model for Austria – recording the interactions between SDG13 & other SDGs to simulate development paths & costs

Centre for Global Change and Sustainability, University of Natural Resources and Life Sciences (BOKU)

Millennium Institute

StartClim2021.B: Societal cost-benefit analysis of investments in sustainable personal mobility in urban and rural areas in Austria

Institute for Advanced Studies (IHS)

Vienna University of Technology (TU Wien)

StartClim2021.C: #mypart – Raising awareness of the significant impact of small contributions to climate protection

Austrian Institute of Technology GmbH (AIT)

StartClim2021.D: Conceptual development of a web-based dashboard for communicating modelling results on climate change mitigation in agriculture

Institute of Sustainable Economic Development, University of Natural Resources and Life Sciences (BOKU)

StartClim2021.E: Climate-friendly everyday practices – a participatory science communication project for adolescents and young adults with migration background

Wiener Volkshochschulen, Abteilung Innovation und Internationales

StartClim2021.F: KO-TRANSFORM – Novel pathways for achieving agreement in the transformation of urban spaces for water management and climate adaptation

Institute of Sanitary Engineering and Water Pollution Control, University of Natural Resources and Life Sciences (BOKU)

Institute of Urban Water Management and Landscape Water Engineering, Graz University of Technology

StartClim2021.G: Remote sensing-based monitoring and data-driven modelling of surface water bodies in Neusiedler See – Seewinkel National Park **(FEMOWINKEL)**

Department of Geodesy and Geoinformation, Vienna University of Technology

StartClim2021.H: The societal relevance of spontaneous development of nature in cities

Institute of Landscape Development, Recreation and Conservation Planning, University of Natural Resources and Life Sciences (BOKU)

StartClim2021.I: Modelling water demand for green walls **(MEADOW)**

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Table of contents

Abstract

StartClim has been studying adaptation to climate change since 2008. The projects in StartClim2021 addressed various research questions, such as trade-offs between SDGs, costs and benefits of personal transport, pro-environmental decision-making in agriculture, climate-friendly everyday practices, and acceptance of urban wilderness.

iSDG_KlimAT: An SDG model for Austria - recording the interactions between SDG13 & other SDGs to simulate development paths & costs

iSDG_KlimAT focused on modelling the Sustainable Development Goals (SDGs) to identify connections between SDG13 and other SDGs. The overarching goal of the project was to establish a national SDG model for Austria in order to identify synergies and trade-offs between the climate goals and other SDGs and the associated cost aspects. For this purpose, several qualitative and quantitative methods from system dynamics were used. The internationally established system dynamics computer model iSDG from the Millennium Institute was adapted for Austria, and a stakeholder and expert workshop was organized to identify the systemic effects of various mitigation strategies. As a result of the project further development steps were derived from the quantitative model development process. This will make the model fully applicable in the Austrian context and permit more specific analyses of climate change adaptation and mitigation strategies and the associated costs.

At the national level, improved integration of financial data is needed. At the regional level a more detailed breakdown of individual sectors and the structural integration of more specific adaptation measures and their related structure into the iSDG model would also be beneficial. In addition to these quantitative aspects, we established the basis for further development of model structures, specifically climate change mitigation strategies, in a stakeholder and expert workshop. This was done using participatory modelling tools to map out structures underlying selected mitigation strategies (ban on fossil-fuel vehicles, building standards, ban on fossil heating systems and carbon tax) together with experts and stakeholders. On this basis, initial synergies and conflicting goals were noted. The method used (causal loop diagrams) provided a systemic overview of the participants' knowledge of the system and provided new insights into climate protection measures and associated dynamics. For example, the positive effect on poverty through investment, and training programmes that would be necessary in connection with individual measures was identified. However, it also became clear that this synergistic effect would not be immediate. The project provides a basis for further projects (ACRP – SDGVisionPath & Horizon Europe – TANDEM) dealing with the modelling of SDGs. The participatory approach will also continue in these two projects. Participatory modelling elements were also seen to be useful for developing holistic regional climate protection and adaptation strategies, as they enhance systemic understanding of the complex challenges related to climate change and can reveal important intervention points.

Societal cost-benefit analysis of investments in sustainable personal mobility in urban and rural areas in Austria

The object of this project was to link the strategic land use and transport interaction model MARS (Metropolitan Activity Relocation Simulator) with an economic assessment of investments in sustainable personal mobility by means of a cost-benefit analysis. Using the MARS model, we calculated different scenarios to investigate relationships between investments in sustainable personal mobility and benefits of avoided external and emission certificate costs. The purchase of emission certificates can be avoided by reducing passenger car traffic. The aim was to determine the feasibility of this model linkage and to highlight the societal benefits of changed mobility behaviour by the population. For this purpose, we included a series of external costs so as to quantify air pollution, noise emissions, climate damage, accident costs and effects on health in monetary terms. The applicability of

this model linkage was tested using a MARS scenario for the decarbonization of the Austrian transport sector by 2040 with a predefined mix of measures. Decarbonization would significantly reduce greenhouse gas emissions in the transport sector. The project demonstrated the feasibility of this linkage, although there are limitations to consider. The cost varies greatly depending on the scenario because of the relevant assessments of external costs. By comparing all considered costs and benefits (Fig. 2:) in the three scenarios 1A, 1B (inclusion of external costs, different weighting of future climate-related damages) and 2 (exclusion of external costs) it is possible to determine the overall investment cost of the mix of measures over the entire period between 2022 and 2040 and to contrast it with the benefits of the respective scenarios. The most beneficial scenario was 1B. In scenario 2, the costs outweighed the benefits, as no saved external costs were included, which led to a distorted picture. A positive net result (net benefit exceeds net cost) was achieved only in scenario 1B because of a higher valuation of climate-related damages. It should be noted that the project focused on public spending and could not consider all relevant factors. Based on the results, recommendations were made for investing in public transportation, cycling and pedestrian mobility in line with a cost-efficient reduction path regarding the decarbonization of the Austrian transport sector.

#mypart - Raising awareness of the significant impact of small contributions to climate protection

The issues of sustainability and climate change have low priority in the everyday lives of young people. However, the consequences of climate change are becoming increasingly evident, and young people will be particularly affected by them in the future. At the same time, they are good multipliers when it comes to initiating social change. The project #mypart supported students at GRG 21 Vienna in dealing with climate issues and habits by first addressing the climate system and the significance of climate models. The different types of behaviour and patterns were examined to enable the students to develop strategies to foster awareness of sustainable change. For this purpose, four workshops were held together with the students. In the fourth workshop they were able to apply what they had learned from the first three workshops. Before the first workshop, the students took part in a survey to determine the state of knowledge and attitude. The questionnaire was supplemented by a quiz designed to draw the students' attention to facts and misconceptions in a non-judgmental way. In the fourth workshop, the students presented the results of the application phase to the project team and their peers in a form of their own choosing . Finally, the jury awarded prizes to the groups. An evaluation format was chosen that ensured that all groups received prizes and recognition. The collaboration with the highly motivated class and its teacher worked very well. The chosen methodology heightened the group's awareness of the issue and empowered them to actively engage in the preparation and implementation of targeted action on climate change. Although the first two workshops took place online because of the pandemic, it was easier to keep the students' attention on site and to assess whether they understood the content presented. Despite these limitations, the ideas developed show that the young people are highly motivated to actively participate in finding solutions. The approach developed in the project proved to be very successful and generated a very positive response from both the students and the teacher involved. The materials created and the method can be used very well.

Conceptual development of a web-based dashboard for communicating modelling results on climate change mitigation in agriculture

Globally, the agricultural sector accounts for almost half of the total non-CO_2 greenhouse gas (GHG) emissions, with methane (CH_4, mainly from enteric fermentation from ruminant animals) and nitrous oxide (N_2O, mainly from fertilizer application) accounting for the largest shares. In Austria, agriculture accounts for about 10 per cent of the national GHG emissions), with CH_4 and N_2O accounting for 65 per cent and 34 per cent, respectively. To achieve the ambitious European and Austrian climate targets, a reduction of GHG emissions is necessary in all sectors, including the agricultural sector. Recent research confirms the technical feasibility and effectiveness of GHG reduction measures in that sector. However,

their implementation is sluggish. Targeted and clear communication of scientific results together with cooperation between scientists, farmers, policymakers and society is needed to increase awareness of climate mitigation measures and potential and to advance the adoption of climate mitigation measures in the agricultural sector. This project aimed at developing a concept for an interactive web platform for the communication of climate mitigation-relevant results from land use modelling. The relevant benchmarks to be presented in the interactive web platform were determined together with farmers. For that purpose, semi-structured interviews were conducted with crop and livestock farmers and qualitatively analysed. The farmers were asked about their knowledge and expectations, and experience with and implementation of management measures that contribute to the reduction of farm-level GHG emissions. They were questioned in addition about their information behaviour and their attitude towards the planned web platform. The results show that many farmers are already implementing management measures to reduce GHG emissions in the agricultural sector. However, their decision to implement a particular management measure is not influenced by the GHG reduction potential, and farmers have little information about the climate (mitigation) effect of their farm and land management. This indicates the need for an increased knowledge transfer, e.g., via the targeted, interactive web platform, to facilitate the implementation of climate mitigation measures by farmers. The decision for or against management measures is mainly influenced by economic considerations (costs, savings, yield expectations). The majority of the interviewed farmers were interested in the interactive web platform to present and compare the GHG reduction potential of management measures. Besides the GHG reduction potential and the consideration of detailed site-specific conditions (e.g., soil properties, local climate conditions), the presentation of economic benchmarks, such as costs, benefits, and crop yields, was mentioned as an incentive for using the interactive web platform.

Climate-friendly everyday practices – a participatory science communication project for adolescents and young adults with migration background (klAP)

Recent surveys in Austria confirm that there is a clear disparity between knowledge about climate change and climate-friendly behaviour in everyday life. For several years, various educational measures have been taking place in Austria, especially in schools, to activate climate change awareness and climate-friendly behaviour. However, two target groups are not reached by these measures: adolescents and young adults who are no longer in formal education. The proportion of youths and young adults with a migration background is higher than among those without a migration background.

These two target groups were reached via youth coaching and training programmes and German and integration courses at adult education centres in Vienna. The project was based on a bottom-up participatory approach. With the help of narrative interviews, participants identified the everyday areas that form the ecological footprint on the basis of their own life experience: housing, food, mobility and consumption. With the knowledge of their own ecological footprint and additional scientific facts on climate change, the participants developed packages of measures to combat climate change that were relevant in their everyday lives and could be implemented by them.

The result of the project is a participatory didactic tool in a workshop format for people with a migration background, which is freely available in an open-access format. It is particularly suitable for German as a foreign or second language courses and German and integration courses from language level B1.2/B+. It equips participants with a scientific working method and deepens their language skills through the interactive format. It covers a real-life topic that affects everyone and supplements the above-mentioned course curricula, in which climate change has so far been addressed only in isolated areas.

KO-TRANSFORM - Novel pathways for achieving agreement in the transformation of urban spaces for water management and climate adaptation

In the KO-TRANSFORM project, a method for better consensus building in the climate-sensitive transformation of urban water systems and green space management was tested in a multi-stage co-creation process with the municipality of Gleisdorf. Quantitative storytelling was combined with a subsequent multi-criteria decision analysis conducted by the local stakeholders using an online tool for ranking different measures according to personal preferences. Two participatory workshops were held in the community to facilitate transdisciplinary collaboration on climate change adaptation and to generate ideas and preferences regarding the transformation of urban green and open spaces. A particular focus was on using "blue-green-brown" infrastructures in urban water management adaptation and as measures for enhancing liveability in public spaces. These measures were generally considered attractive and effective by stakeholders but were not universally regarded as desirable solutions for Gleisdorf. Regulatory restrictions, competing uses of the limited space in the municipality, and diverging ideas and desires regarding the design and feel of the urban space were identified as key challenges during the participatory process .

Remote sensing-based monitoring and data-driven modelling of surface water bodies in Neusiedler See – Seewinkel National Park (FEMOWinkel)

The FEMOWinkel project aimed at characterizing the hydrology of the salt pans of the Seewinkel using satellite imagery acquired since 1984. The wetlands in the far east of Austria are of great importance for the biodiversity of the area. They represent unique habitats for specially adapted animals and plant species and are important for local tourism. Their preservation relies to a large extent on the water balance in Seewinkel. Because of their shallow depth, the large number of salt pans are often inundated with water only for short time and partially dry up in summer, making monitoring by means of in-situ gauges difficult. Satellite remote sensing can bridge this gap by providing spatially consistent data so as to permit the automatic derivation of relevant information. In the FEMOWinkel project, long-term satellite data series were made available for monitoring and modelling of the extent of the salt pan. The monthly situation was determined on the basis of a sequence from Landsat satellites providing data since 1984. Machine learning was then used to develop models to predict the extent of the salt pans and identify drivers using climate (precipitation, temperature, evaporation) and groundwater level data. Results show that for a large number of wetlands a short-term forecast on the drying state is possible in early summer. With longer lead times the probability of making a correct forecast decreases. Data-driven modelling of hydrological processes is a relatively recent field, and the project results could therefore be of use to the scientific community. The results are also important for monitoring salt pans with no in-situ gauges and identifying wetlands in particular danger of drying up.

The societal relevance of spontaneous development of nature in cities

This research project investigated the social acceptance among the inhabitants of Vienna of urban wilderness areas. Based on secondary data, field observations and a survey (n=800), different types of urban wilderness in Vienna were identified and their social and ecological significance characterized and analysed. The study revealed highly diverse urban wilderness areas in Vienna. Three such manifestations were examined in depth: urban forests, urban wastelands and natural meadows. The survey showed that all three types of urban wilderness are of great socio-cultural importance and that the majority of respondents would accept them as alternatives to grassland in urban parks and as design elements of new urban neighbourhoods. Urban wastelands were less accepted by all social groups, but differences among social groups and related conflict potential were particularly evident in urban forests and natural meadows. These tended to be rejected more frequently by persons under 25 years of age, with lower levels of education, from non-EU countries and those with children. The study results indicated that there is great societal potential for protecting and promoting urban wilderness areas in Vienna. The different characteristics and benefits of the three types of urban wilderness offer

the city administration the opportunity to promote wild urban nature in different ways and adapt its use to the city context and the needs of the urban inhabitants.

Modelling water demand for green walls (MEADOW)

Vertical green systems (VGS), or green walls, are versatile, nature-based systems for addressing a wide range of urban water management challenges while mitigating negative impacts of climate change. For example, VGS can be used for decentralized greywater treatment, while cooling buildings and plazas in the process. Because of their vertical design, these multifunctional structures can be used both in new buildings and in existing, densely built-up areas.

However, regardless of their intended function(s), VGS require sufficient water supply to ensure sustainable operation, tailored to their location. Despite the versatility of green walls, the irrigation requirements have not been studied to to the same extent as other green infrastructures, such as green roofs.

To bridge this gap, the MEADOW project looked at data from an experimental green wall to explore the potential of machine learning models for predicting green wall water demand.

The models developed for MEADOW were used to estimate irrigation requirements as a function of the design of the VGS and the meteorological conditions on site. They represent a first step towards the systematic quantification of the requirements for grey and rainwater storage and the identification of monitoring requirements for the automated, long-term operation of green walls. Subsequently, flexible planning tools will be developed based on MEADOW's findings, which will enable decision-makers, planners and stakeholders to evaluate and discuss the use of VGS and, if appropriate, streamline their use.

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 StartClim2021 projects examined different aspects of relevance to climate change adaptation in Austria.

The StartClim2021 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 StartClim2021 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.

StartClim2021.A: iSDG_KlimAT: An SDG model for Austria – recording the interactions between SDG13 & other SDGs to simulate development paths & costs

Background

Since 2008, StartClim projects have been addressing a wide range of climate change issues. Ambitious climate targets are currently being set at EU and national level. At the same time, the United Nations Sustainable Development Goals (SDGs) adopted as part of Agenda 2030 have to be achieved by 2030. In addition to various social, environmental and economic goals, there is a separate climate goal – SDG13.

In order to reduce costs and achieve as many of the set goals as possible (efficiently), it is important to understand how these goals are interconnected. There are now a large number of studies that use a wide variety of methods to identify the interactions between the different goals. One such method, the Nilsson Scale, was used in 2018 in the StartClim project CliPo_Interlink to map synergies and trade-offs between SDG13 and other SDGs. This method is suitable for representing conflicting goals and synergies statically. However, the impact of individual measures over time cannot be represented.

Project goals & methods

Building on the previous work, the goal of this project was to understand how measures to achieve SDG13 affect the system holistically (also other SDGs) over time, what synergies and trade-offs arise, and what this means for cost aspects. Furthermore, the goal was to apply and test qualitative and quantitative methods using system dynamic modelling in the Austrian context. For this purpose, iSDG, an internationally established system dynamics SDG model from the Millennium Institute, was adapted for Austria, and a stakeholder and expert workshop was held, in which elements of participatory modelling (i.e., causal systemic impact diagrams) were used.

Insights from the model development process

The iSDG was originally developed and applied to identify holistic measures for achieving the Millennium Development Goals (MDGs) in countries of the Global South, but it is now being used increasingly in countries of the Global North. In total, the model covers thirty sectors of the iSDG in the environmental (green), social (red) and economic (blue) domains. Because the model covers all SDGs, it supports a better understanding of the interrelationships between the goals and the existing synergies and trade-offs. Although SDG13 is linked directly or indirectly to all other SDGs, there are sectors in the current model that have particular relevance to SDG13 (Fig. 1:). These include emissions and waste, energy supply, energy consumption, vehicles, agriculture, land use, soil, infrastructure, (industrial) production, and mortality. While the latter play a role mainly in climate change adaptation, the sectors mentioned at the beginning are particularly important for climate protection. Currently, the model can represent the following climate-relevant measures: investments in climate change adaptation, energy efficiency improvements in households and industry, efficiency improvements in the vehicle sector, and investments in hydropower, wind and photovoltaic plants, and reforestation (Fig. 1:). The necessary additional development and adaptation steps derived from the model development process to make the model even more relevant for the Austrian context are therefore:

1. use of improved financial data at the national level;
2. revision of the energy and agriculture sectors;
3. integration of additional climate change mitigation measures and related system structures;
4. more detailed breakdown of individual sectors at the local level (e.g., agriculture, land use and water sectors);

5. structural integration of more specific adaptation measures into the iSDG model at national and local levels;
6. integration of additional SDG indicators relevant to Austria.

Although a first calibration of the model was possible and a Business As Usual (BAU) scenario was modelled, it was decided not to conduct further scenario analyses because of the necessary improvements that would be involved.

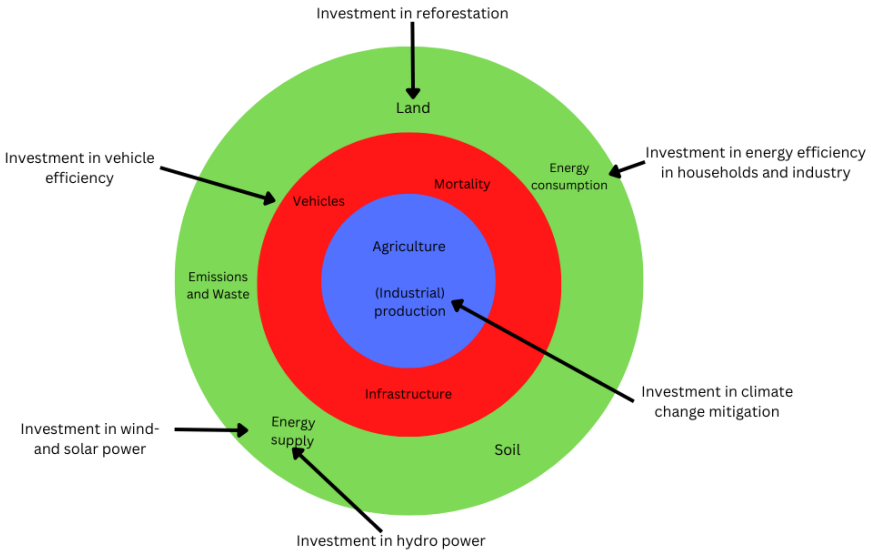

Fig. 1: iSDG_KlimAT overview

Insights from the participatory expert and stakeholder workshop

However, as the investments in technologies and efficiency improvements depicted above are far from sufficient, the systemic impact of further measures (i.e., carbon tax and ban on fossil-fuel vehicles and heating systems, and building standards) were elaborated in a participatory stakeholder and expert workshop to lay a foundation for the further development of the model (see also point 3). One of the main results is that the measures taken lead to synergy effects with poverty targets. However, as these are associated with training and subsequent employment in the higher to highly skilled sector, there is a some delay before they take effect. In addition, the following main points can be derived from the systemic impact diagrams created by stakeholders and experts:

- **A) Ban on fossil-fuel cars:** if the number of cars on the road were reduced by the ban, there would be a shift to public transport and bicycles. This would have a beneficial effect not only on the environment but also on health. However, the increase in electric vehicles in traffic as a result of price reduction would counteract these effects.
- **B) Building standards:** Although there are possible synergies between the establishment of building standards and the reduction of poverty, a lot would depend on the interventions in the field of education and employment.
- **C) Fossil-fuel boiler ban:** The positive dynamics created for boiler replacement are self-reinforcing, but they also drive potential trade-offs with the agricultural sector and the environment.
- **D) Carbon tax:** state budget revenues and consumption are central to achieving the CO_2 target and mitigating potential negative dynamics and strengthening synergies regarding technological progress and education.

The application of CLDs also improved the workshop participants' knowledge of the system and enabled them to gain new insights into climate change mitigation measures and their holistic effects.

Conclusion & outlook

iSDG_KlimAT has created a good basis for further analyses, also regarding costs, and for further projects (ACRP – SDGVisionPath & Horizon Europe – TANDEM) dealing with SDG modelling. In the two follow-up projects, not only will the participatory approach of system dynamic modelling be further pursued, but the quantitative scenario modelling of SDGs will also be further developed. Furthermore, the elements of participatory modelling are also suitable for developing holistic regional climate change mitigation and adaptation strategies, as they can improve the systemic understanding of the complex challenges of climate change and reveal important entry and leverage points and potentially related short- and long-term impacts.

StartClim2021.B: Societal cost-benefit analysis of investments in sustainable personal mobility in urban and rural areas in Austria

Achieving the climate protection targets of the 2015 Paris Agreement requires a profound transformation of numerous areas of life. The Special Report of the International Panel on Climate Change (IPCC) emphasizes that, among other things, radical changes in the areas of transport, energy and infrastructure are necessary to achieve a reduction path of net-zero greenhouse gas emissions by 2050. With a share of 30 per cent of greenhouse gas emissions in 2019, the transport sector is the second largest emission source in Austria after the energy and industrial sector. In line with the Paris goal, the Federal Ministry of Climate Action and Energy has developed the Mobility Master Plan 2030. It contains a reduction path for greenhouse gas emissions by the transport sector that includes extensive investments in sustainable personal mobility.

The project sought to link the MARS (Metropolitan Activity Relocation Simulator) traffic model from the Vienna University of Technology with an economic assessment of investments in sustainable personal mobility by conducting a cost-benefit analysis that included external costs. The MARS model serves as a basis for the calculation of scenarios for investments and cost savings through more sustainable personal mobility. Two method guides and a paper were used to calculate the external cost savings. The feasibility of this link was tested in a specific scenario for the decarbonization of the Austrian traffic sector by 2040 (observation period 2022–2040), based on a predefined mix of measures. It was possible to link the MARS model with the cost-benefit analysis, albeit with limitations: the model focused on average values for the external costs, for example, rather than differentiating between rural and urban areas. Despite these limitations, important conclusions can already be drawn.

A comparison of all considered costs and benefits (Fig. 2:) in the three scenarios 1A, 1B (inclusion of external costs, different discounting of future climate-related damages) and 2 (exclusion of external costs) revealed that while the overall investment cost for the mix of measures amounted to approximately 50.2 billion euros over the entire period between 2022 and 2040, there were different benefits within the respective scenarios. The most beneficial scenario was 1B with benefits of 54 billion euros, followed by scenario 1A with almost 44 billion euros. In scenario 2, the costs outweighed the benefits, as no saved external costs were included, which produced a distorted picture. A positive net result was achieved only in scenario 1B because of a higher valuation of climate-related damage. Scenario 1A, however, was significantly more beneficial than scenario 2, despite its overall slightly negative balance. It should be noted that the project focused on public spending (investment costs) and could not consider all relevant factors. Moreover, extensive investments in sustainable personal mobility are essential in view of the urgency of implementing the energy and climate transition. The inclusion of external costs is a necessary step for approximating the actual costs of fossil-based personal mobility.

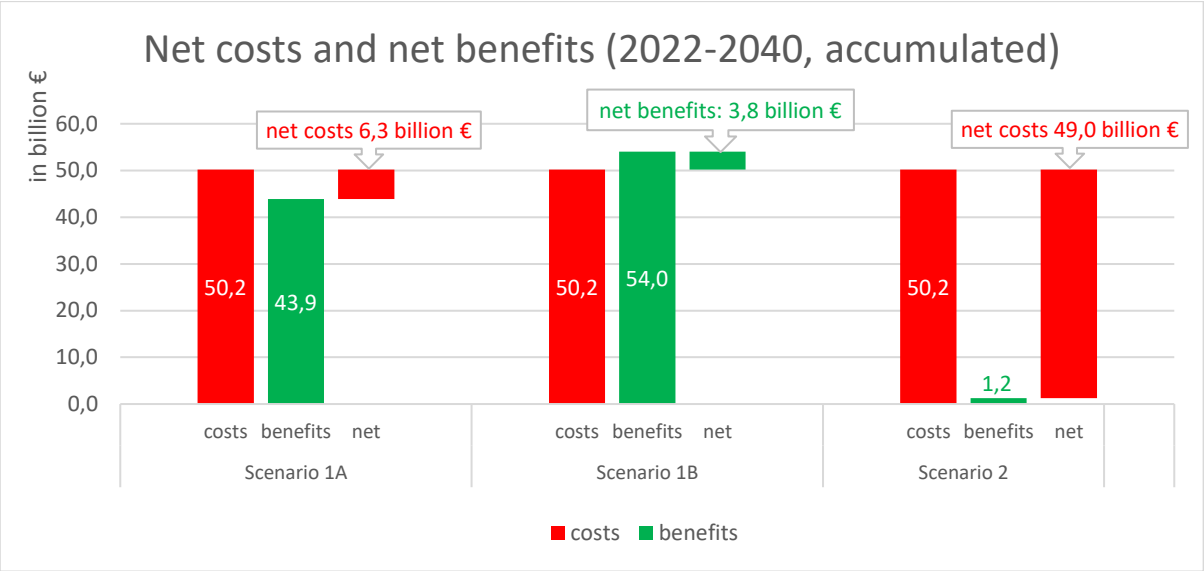

Fig. 2: Comparison of costs and benefits for three scenarios

Regarding the relevance of external costs, a few cost categories dominated the monetary evaluation: accident costs, which are mainly driven by the many fatalities among motorcyclists, congestion costs, which are classified as particularly important in classical cost-benefit-analyses, and climate-related damages, which are weighted differently depending on the data basis and assessment method.

A sensitivity analysis was conducted to better assess the limitations and uncertainties,. Apart from the base scenario considered so far, which is defined as the medium case, best and worst cases were calculated as well. Even in the worst case, the external cost savings were still around 31.6 billion euros over the entire period between 2022 and 2040. The external cost concept is thus useful for visualizing societal benefits.

It is recommended that all measures implemented and quantified in the MARS model be put into practice as important components on the way to a decarbonization of the transport sector by 2040. The measures include the expansion of infrastructure for pedestrians and cyclists (widening of pavements and installing cycle paths, marking of bicycle lanes, adjustment of traffic light cycles, and a redistribution of public spaces). Regarding public transport, we advocate a reduction in fare prices and an increase in the number of stops and the service frequency, ideally with complete or partial compensation for any losses incurred as a result by the transport companies. The introduction of a mileage-based toll for car traffic is also recommended. The expansion of the bicycle infrastructure and an increase in the number of public transport stops, particularly bus stops, would be particularly cost-effective. In addition to these traffic management recommendations, further external developments are crucial. These include a denser construction of new buildings and the establishment of electric mobility. Furthermore, the current carbon price planned in Austria is far below the recommendations in the literature and will be insufficient to bring about the necessary behavioural changes. A higher carbon price is required that emphasizes the urgency of the issue but must be accompanied by social compensation measures in order not to exacerbate the disadvantages of some segments of the population.

StartClim2021.C: #mypart - Raising awareness of the significant impact of small contributions to climate protection

Sustainability and climate change topics are not very prominent in the everyday lives of young people, even though the consequences of climate change are becoming increasingly noticeable, and this age group will be particularly affected by them in the future. On the other hand, they are good multipliers when it comes to initiating social change. However, young people feel powerless in the face of climate change, are unaware of the connections with their own lifestyle and underestimate its influence.

The project #mypart supported students of GRG 21 Vienna in dealing with climate topics and habits by looking at the climate system, the significance of climate models and climate researchers, and presenting the different types of behaviour and their values. Based on this, strategies for different identified target groups were developed by the students to encourage sustainable behaviour. Workshops on natural conditions and research on motives, attitudes and barriers to change helped the students to develop concrete change strategies in small working groups for different everyday areas (e.g., mobility, waste, consumption). Each of these strategies focused on a specific type of behaviour and was tested for effectiveness on samples in the students' own social environment. The methodology was based on the findings of previous youth projects (e.g., youth codes, www.youthcodes.at) and included a survey of the students' current level of knowledge. Building on this, four workshops were held with knowledge transfer from research, interactive elements for design in groups and individually by the young persons themselves.

Based on the current knowledge of climate change causes, climate impacts, protection, and adaptation measures and on the attitudes and motivations of the different social groups, a survey was devised to ascertain the level of knowledge in that regard among the target group (questionnaire) and to familiarize them with the topic. The results of the survey showed that climate change is not a dominant topic in their lives and is most likely to be addressed at school and, to a lesser extent, in the family. In terms of awareness of climate impacts, all of the students were certain that they would feel the consequences of climate change themselves and that there would be more weather extremes. The effects on everyday life were assessed differently, with bans or restrictions being considered unlikely but home offices and CO_2 information on the consumer goods already conceivable for most. The responsibility for action was mostly seen to lie with politicians.

Based on the results of the survey, the participants had a direct influence on the further design of the workshops, which were organized so that the degree of co-determination was gradually built up. Because of the pandemic, the first two workshops were virtual (supported by interactive elements, e.g., Miroboards):

- Workshop 1: Age-appropriate topic-related knowledge transfer and collection of questions about the level of interest and gaps in knowledge
- Workshop 2: Development of approaches for the activation of others
- Workshop 3: Self-determined design and subsequent implementation of a project with the aim of sensitizing a target group and encouraging them to change their behaviour. Group 1 defined the reduction of plastic bottles among students as a goal; group 2 tried to raise the awareness of the topic by younger children (kindergarten, primary school) and their caregivers; and group 3 gave students and teachers from GRG21 special tasks (e.g., abstaining from meat consumption, buying regional products).
- Workshop 4: Freely selectable presentation by the three working groups, with a focus on goal achievement, transferability, barriers and achieving the greatest change in behaviour. Further criteria for a final award were the most original form of presentation (final presentation) and most original approach (creativity of the method). An evaluation format was chosen that ensured that all groups received prizes and recognition.

The class was very motivated, and the cooperation worked very well, helped by the chemistry teacher, who integrated the topic into the regular lessons. Other teachers also responded positively to the students' requests to present the project in their classes or to participate in a task themselves. The target groups selected by the students ranged from kindergarten and primary school children, to their own age group and the teaching staff, in this way illustrating the potential for young people to act as multipliers.

In general, the following recommendations can be derived for the cooperation with the students, which can also be applied to other topics. For the format used in the project, a school class in the age range of 14 to 18 is best suited. It is important that the young people already know each other well in order to ensure that they can discuss openly with one another (cooperation group). The involvement of a teacher who is committed, knows the group well and also genuinely supports the objective is important for implementation (accompaniment). At least two to three weeks should elapse between each of the workshops to give the students time to reflect on the topic and to gather their own experience. Each workshop should include activities for the time in between. Although the format can be held virtually with online work environments, face-to-face workshops are better, especially for external facilitators, to permit observation of the students' reactions to the content and to create more interest (place of implementation). When communicating with young people, it is important to relate the topic to the students' lives and to formulate it from the perspective of the target group. In addition, the content and activities should aim for as high a level of participation as possible (participation, co-determination, self-determination) and include or focus on the opinions of young people at every stage. It is important for committed young people not only to contribute creative ideas, but also to be able to make a difference (attention, resonance, and impact), all the more so in a world in which they often do not feel that they are taken seriously.

Fig. 3: Four steps for climate change awareness

StartClim2021.D: Conceptual development of a web-based dashboard for communicating modelling results on climate change mitigation in agriculture

In Austria, the agricultural sector accounts for about 10 per cent of the national greenhouse gas (GHG) emission, with non-CO_2 GHG emissions being of major relevance (CH_4 methane, and N_2O nitrous oxide). The most important emission sources are enteric fermentation from ruminant animals (around 57%), followed by fertilizing agricultural soils (around 28%). The EU and Austria have made the reduction of GHG emissions a major policy objective, with a view to becoming climate-neutral by 2050 (EU) and 2040 (Austria). In order to achieve this ambitious climate target, several strategies and regulations have been developed and implemented. They attribute responsibility for GHG emission reduction to all sectors, including the agricultural sector. Land use modelling can provide important information on the technical feasibility, effectiveness and efficiency of climate mitigation measures in the agricultural sector, and several studies are available that confirm the effectiveness of climate mitigation measures. However, the lack of communication and exchange between academics and society is an obstacle to the adoption of these climate mitigation measures and a reason why it is still limited. The WebKomKlima project was designed to foster the communication of scientific results to assist in the implementation and selection of GHG reduction measures in the agricultural sector and contribute to achieving political climate goals.

The major objective of the project was to develop a concept for an interactive web platform to communicate land use modelling results on climate mitigation measures in the agricultural sector (Fig. 4:). A platform of this nature could enable farmers to evaluate the effect of technical and management measures on GHG emissions at farm level. This includes the effect of changes in management measures such as fertilization rates, manure storage, or the use of technologies such as precision farming or fertigation.

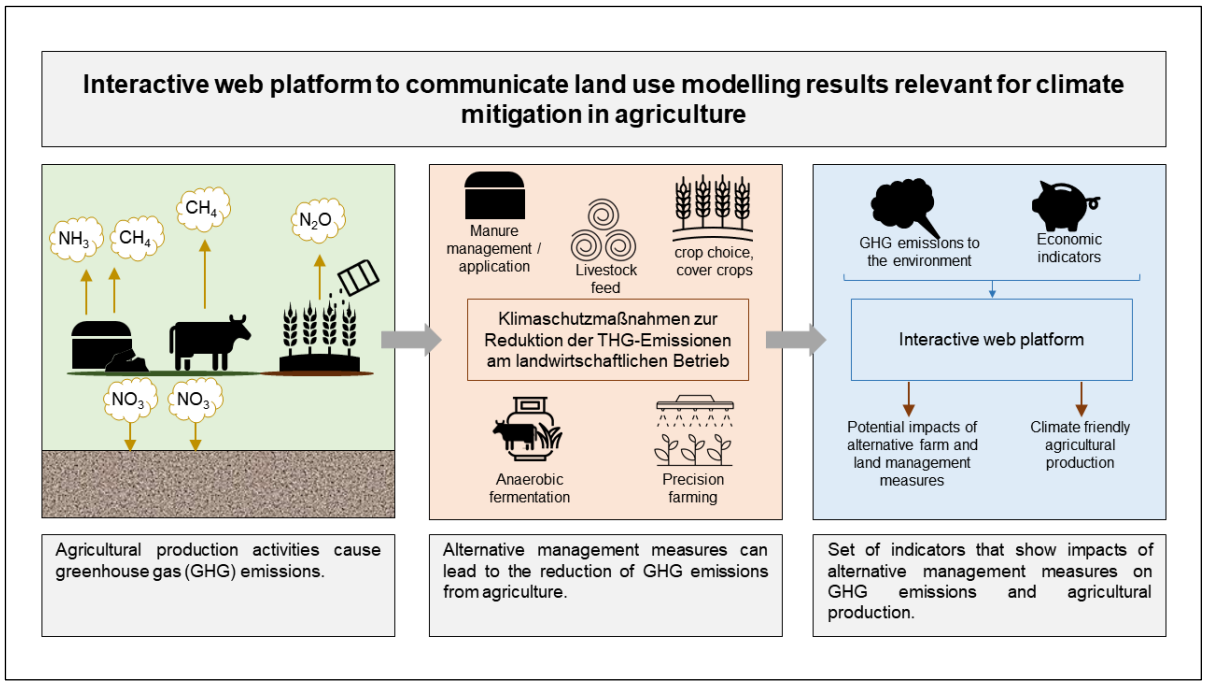

Fig. 4: Concept for the interactive web platform

An extensive literature review was conducted to identify management measures in agriculture relevant to climate change and to obtain information on the implementation of interactive web platforms. The focus was on management measures relevant to non-CO_2 GHG emissions that can be implemented on

the farm without significant investment. This includes adjustments to fertilizer intensities and crop rotation, and also storage and application techniques for farm manure. Measures such as the livestock housing system and a conversion from conventional to organic farming were not included. The reviewed literature was summarized and structured. Measures with GHG reduction potential identified in the crop farming sector are fertilization, site-adapted crop type selection and tillage and sowing of cover crops. In livestock farming, manure management, grazing and feeding have a significant impact on farm-level GHG emissions.

Based on the literature review, an interview guideline was developed, and interviews were conducted with Austrian crop and livestock farmers. Central themes in the interviews were (i) the perception of climatic change and the impact on their own farm, (ii) their attitude towards and knowledge of climate-relevant management measures, and (iii) their information behaviour and attitude towards the use of interactive web platforms. The interviews provided valuable information for the design of an interactive web platform. The qualitative content analysis showed that many farmers already implement management measures with which they contribute to GHG reduction. However, farmers are not well informed about the impact these have on climate. Furthermore, decisions are mainly made on the basis of economic considerations (e.g., costs, savings, yield expectations). The majority of the interviewed farmers showed an interest in information on the climate impact (or the environmental impact in general) of their farming methods and management measures. For example, one interviewee identified possible opportunities for product marketing. This clearly shows the need for action to promote an increase in knowledge transfer. The interactive web platform could serve as an interface between academics and farmers and support the implementation of climate mitigation measures by farmers. Many interviewees had a positive attitude towards the use of such a platform and could conceive using the information gained from it in their operational planning processes. They also stated that making location-specific information and economic indicators (e.g., costs, benefits, crop yields) available on the web platform was a key requirement.

In planning the interactive web platform, account was taken not only the perspective and needs of farmers. Additional user groups who might benefit from the platform and possibilities for future expansions were also identified. A modular structure is therefore proposed. The following modular diagram provides an overview of identified user groups and the information (input arrows) they could provide to the scientific experts that would enable them to develop the web platform and the data displayed (output arrows).

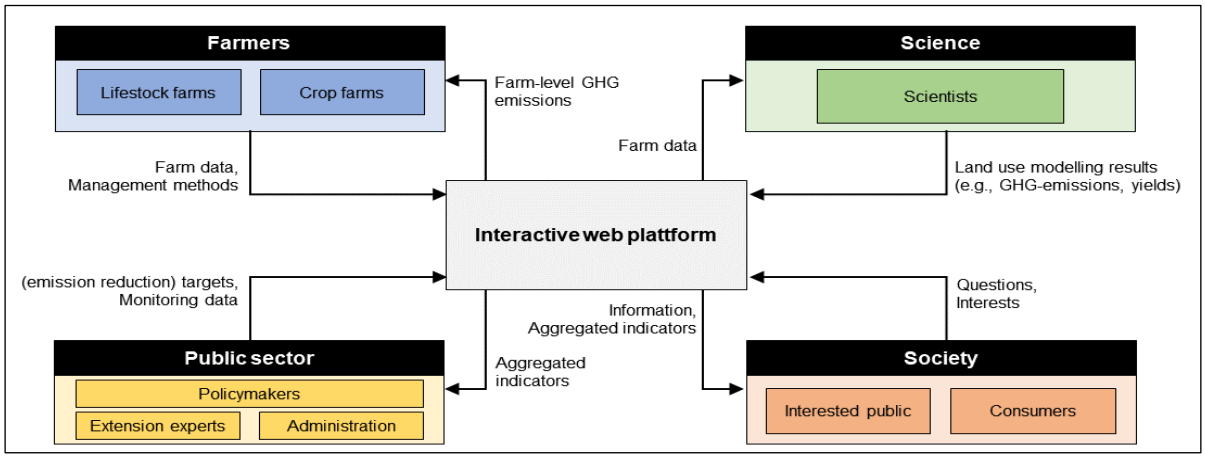

Fig. 5: Key development roles and potential users for the interactive web platform

StartClim2021.E: Climate-friendly everyday practice – a participatory science communication project for adolescents and young adults with migration background (klAP)

Surveys from 2020 and 2021 show that there is a clear disparity between knowledge about climate change and climate-friendly everyday practice in Austria. One of these surveys illustrates the different assessment of the climate issue by people with lower and higher formal educational backgrounds. It also shows that the under-30s in particular are the least open to measures on their own initiative to slow down climate change. For several years, educational measures have been put in place in Austria to activate climate change awareness and climate-friendly behaviour, especially in schools. However, two target groups are not reached by these measures: youths and young adults with low formal educational level. Within this group, those with a migration background are more highly represented. These facts suggest that especially in the federal capital Vienna, which accounts for almost 50 per cent of the population with a migration background, there is a great need for corresponding educational measures.

These two target groups, youths and (young) adults, can be reached through the various youth coaching and training programmes and German and integration courses at adult education centres in Vienna. The youth coaching and training programmes support young people who leave the formal school system after completing their compulsory education and have not yet decided on a further training path. The German and integration courses are attended by young adults and adults who have usually already completed education in their country of origin and who are not yet able to start further training or a professional career in Austria.

Fig. 6: Own life experience as the basis of scientific communication on climate change

But what is the best way to communicate scientific facts about climate change and, in this case, to people with a migration background from the age of 15? What could work as a participatory format, that avoids the deficit perspective of classical assimilation pedagogy and a top-down educational process? And above all, how can people be motivated to take climate-friendly actions in everyday life?

According to the latest findings in scientific communication and environmental education, the format should be based on the values and life experience of the participants. Thus, our project was based on the lives of the participants, who interviewed each other about four areas of everyday life – housing, food, mobility and consumption – in their childhood or youth, using the narrative interview method. In this way, the participants became protagonists and had a different form of perception of themselves, their environment, their history and their experience. The discussion about the results of these interviews and the comparison of these four areas of everyday life, which together form the ecological footprint, provided an opportunity for introducing scientific facts about climate change in this context. By calculating their own current ecological footprint, they established a basis for defining those areas in which more climate-friendly actions could be taken in everyday life. In this way, the participants finally developed their own packages of measures against climate change – with a focus on those climate-friendly everyday practices that were relevant to and feasible for them.

The lasting result of the project is a participatory didactic tool in a workshop format for people with a migration background. After the project has been released, this didactic tool will be made freely available in an open-access format to educators, course instructors of German and integration courses, youth coaching providers and multipliers from the non-school sector.

StartClim2021.F: KO-TRANSFORM - Novel pathways for achieving agreement in the transformation of urban spaces for water management and climate adaptation

The background to this project is the increasingly urgent task of adapting Austria's urban areas to the diverse challenges posed by climate change and enhancing the resilience of the social, ecological, and technical systems within them. In particular, water management as an aspect of urban climate change adaptation – such as dealing with drought and heavy rainfall and the issue of urban heat islands – is entering the public discourse. At the same time, municipalities face numerous other challenges, such as scarce land resources coupled with increasing housing pressure, limited public funds, and infrastructure in need of rehabilitation. Numerous proven measures already exist for adapting urban areas to climate change. Locally effective on-site measures like greening buildings and planting more trees in public spaces have recently been gaining attention. The primary adaptation measures considered in this project are referred to as Blue-Green-Brown Infrastructures (BGB-I). In this umbrella term, "blue" refers to infrastructures with visible water, "green" to infrastructures with visible vegetation, and "brown" to infrastructures with open, active soils.

Public green and open spaces are particularly suited for such measures thanks to the favourable ownership structure and decision-making power held by the public sector regarding the management of these spaces. However, decision-making on the use of public spaces is often marked by conflicting goals and can produce significant disagreements in the local population. Changes in the design, look and feel of public spaces following the implementation of BGB-I can exacerbate existing conflicts of interest. As a result, end users may reject BGB-I measures in the medium- to long-term. Given the different values and perceptions of the local population regarding the degree to which they are personally affected by climate change-related challenges, a more in-depth examination of the dominant positions, framing and narratives should be sought.

Fig. 7: Workshop 1 - Fish bowl discussion and rich picture presentation

A multi-stage co-creation method was conceived and tested in a pilot project in Gleisdorf (Styria), intended to provide a framework for better consensus finding in the climate-sensitive transformation of urban water system and greenspace management. The supervised participatory process involved diverse stakeholder groups. It generated a broader awareness of the different pathways for the sustainable heat- and flood-reducing transformation of Austrian settlement areas. The co-creation approach aimed to increase the acceptance of the identified adaptation measures within the stakeholder groups, as the involvement of the end users is essential to ensure the sustainability of any

given transformation in settlement areas. In this way, heightened interest and a sense of ownership can be instilled in the population and maintained through the regular exchange of information.

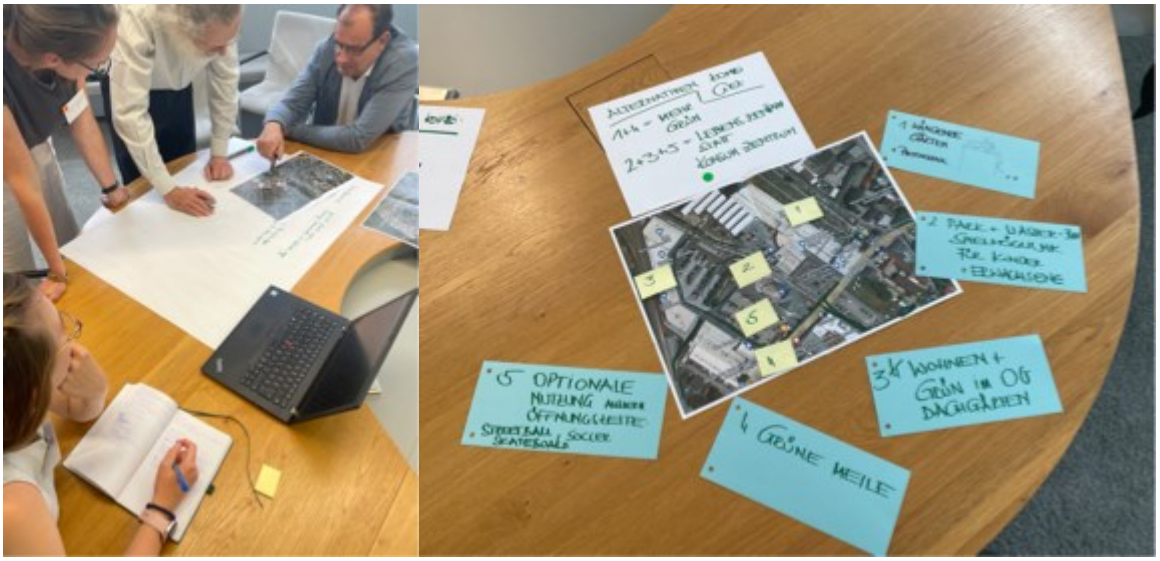

Fig. 8: Workshop 2 - working out the options

To enhance the transferability of the project results and to disseminate the experiences from the Gleisdorf case study, a manual containing recommendations for planning and implementing participation and consensus-building processes in climate change adaptation questions was developed. It is designed to support Austrian municipalities in facilitating the targeted participation of all interested groups to enable consensus-building on issues of the climate-sensitive transformation of public green and open spaces, despite existing conflicts of interest and divergent agendas.

StartClim2021.G: Remote sensing-based monitoring and data-driven modelling of surface water bodies in the Neusiedler See – Seewinkel National Park (FEMOWinkel)

Wetlands are of great relevance for biodiversity. They also fulfil important functions in relation to the regional water cycle. The salt pans in the Neusiedler See – Seewinkel National Park represent an ecosystem that is unique in Central Europe. It is vital for a variety of plant species adapted to the saline environment and provides habitats for breeding and migratory birds. For these reasons, Seewinkel is listed by the Ramsar Convention as a "wetland of international importance". Owing to human interventions and the consequences of climate change, the natural cycle of drying and refilling has been disrupted. While intact salt pans need to dry out from time to time to maintain the salt balance, drainage and extended dry periods have led to a lowering of the groundwater table in the region. This, in turn, leads to increased permeability of the lake bottom, as a result of which precipitation water can infiltrate and is no longer available for evaporation and salt concentration.

Monitoring of water levels and hydrological modelling of the lake water balance are therefore vital for the sustainable management of the Seewinkel region. The large number of wetlands makes it difficult to monitor using installed gauges, many of which have to be read manually. Remote sensing is an important source of information that can provide consistent data on the extent of water. In the FEMOWinkel project, the extent of water over a long period was derived from multispectral satellite data for monitoring wetlands and for data-driven modelling of the water in salt pans. The project focused on the following questions:

- Can multispectral satellite data be used to derive long-term readings of water-covered areas in the Seewinkel salt pans?
- Can water expansion in the Seewinkel region be modelled using machine learning methods and, if necessary, predicted with lead times of just a few months?

In a first step, the water in the salt pans was determined from lolng-term Landsat satellite data since 1984. Machine learning methods were used for this purpose, together with cloud-based processing provided by the Google Earth engine. The readings were validated using independent, manually classified reference data and by comparison with water level data measured in situ. The comparisoon with water level measurements revealed a high correlation for salt pans whose water balance is not artificially altered (Pearson's $r > 0.8$). Lower correlations between extent and level were obtained for artificially fed wetlands (Pearson's r between 0.4 and 0.5). Because of the deeper bathymetry, lower sensitivity between water level and extent is expected for these wetlands.

In the second step, random forest models were trained and evaluated for data-driven modelling of the water expansion in the individual lakes and (where available) of the lake water level. Such data-driven models are typically based on machine learning methods and are especially suited for identifying patterns in large datasets. Input data for the modelling was provided by freely availablemeteorological time series recorded by climate stations and data from the European Centre for Medium-Range Weather Forecasts (ECMWF). Precipitation indices, such as the Standardised Precipitation (Evaporation) Index (SPI/SPEI), were also calculated from the available data. These precipitation indices indicate whether more or less precipitation water is available over a region in relation to the long-term climatic behaviour. They are often used for that reason to characterize drought conditions. Hydrological data from groundwater monitoring wells was also used so as to incorporate the anthropogenic influence of groundwater discharge and abstraction implicitly into the modelling.

A classification approach was used to determine whether it is possible to predict the drying out of salt pans in summer a few months in advance, e.g., as a result of too little precipitation in the preceding winter half-year. The models were built for the months of March to June. The best results were obtained for June; if only data up to March was used, the probability of a correct prediction of complete

desiccation decreased by about 11 per cent. Interestingly, if no groundwater data but only climate data and derived parameters were used, the accuracy decreased by only another 7 per cent, probably because in this case the SPI/SPEI drought indices had a greater influence on the model results and could partly compensate for the missing groundwater information. Owing to the lack of direct information on anthropogenic water use in the area, some negative trends observed in recent years could not be reproduced, especially when applying the models that did not use the groundwater level.

The project results are relevant for the scientific community, as the prediction of hydrological time series using data-driven methods represents a relatively new field. They are also important for monitoring lakes without automatic gauges, which currently has to be done in situ, and for identifying salt lakes that are particularly at risk of drying out. Data on anthropogenic water use (e.g., for agricultural irrigation) would be vital to build more robust models for predicting the vulnerability of salt pans.

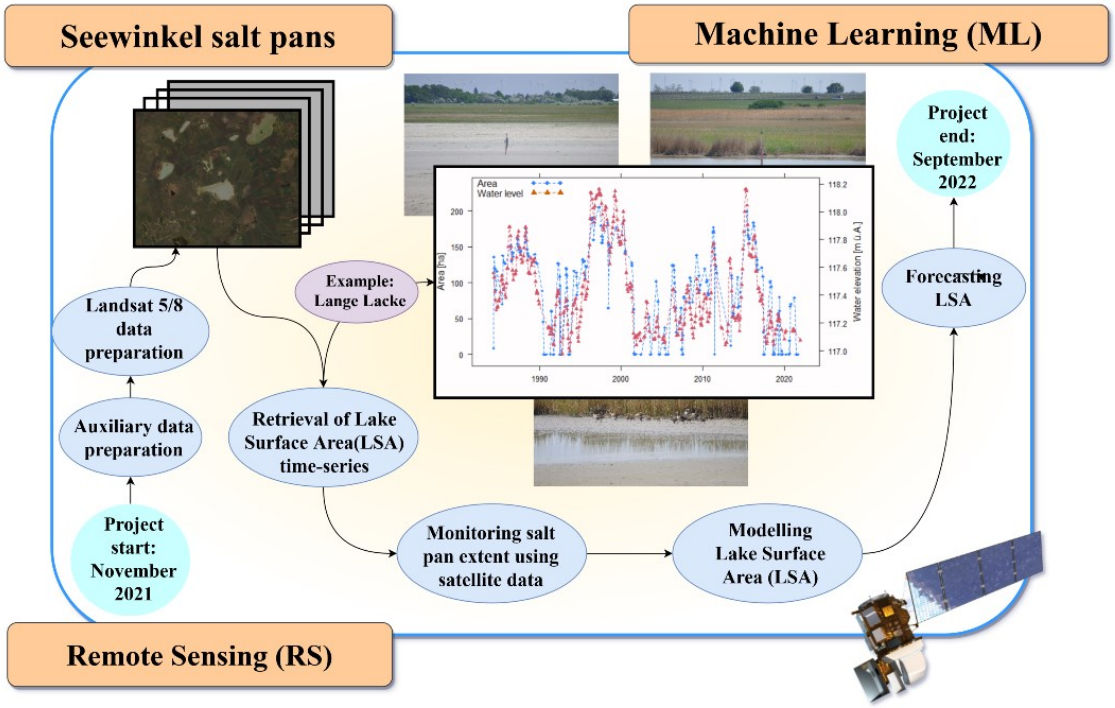

Fig. 9: Overview for the FEMOWINKEL project

StartClim2021.H: The societal relevance of spontaneous development of nature in cities

Today's cities face a multitude of complex sustainability challenges. Besides climate protection, the energy transition or the loss of biodiversity, the challenges lie in promoting a high quality of life and social participation for all. Nature-based solutions such as the promotion of urban green hold a good deal of potential for dealing with these challenges: They contribute positively to the urban climate, create habitats for animals and plants, and foster the recreation and health of city dwellers. Despite their potential, current greening measures are usually characterized by a high maintenance effort and the associated high energy and water consumption, and by high municipal costs. Promoting urban wilderness that requires no or less maintenance can reduce this conflict and represents a possible alternative to traditional green spaces as part of a sustainable and resilient city of the future.

This project investigated the social and ecological significance of urban wilderness areas and their acceptance among residents in Vienna. For this purpose, urban wilderness areas are understood as biocultural systems with a high degree of self-regulation in ecosystem processes, but with considerable differences in terms of their ecological and sociocultural characteristics. Based on this theoretical foundation, the study identified three types of urban wilderness areas that are already widespread in Vienna – urban forests, urban wastelands and natural meadows, described their essential characteristics and, in a further step, examined their acceptance by the inhabitants of Vienna. The evaluation was based on secondary data from a literature review, interviews and workshops and also field observations and a representative survey of Viennese residents of diverse socio-demographic backgrounds (n=800), which were both conducted in the context of the present project.

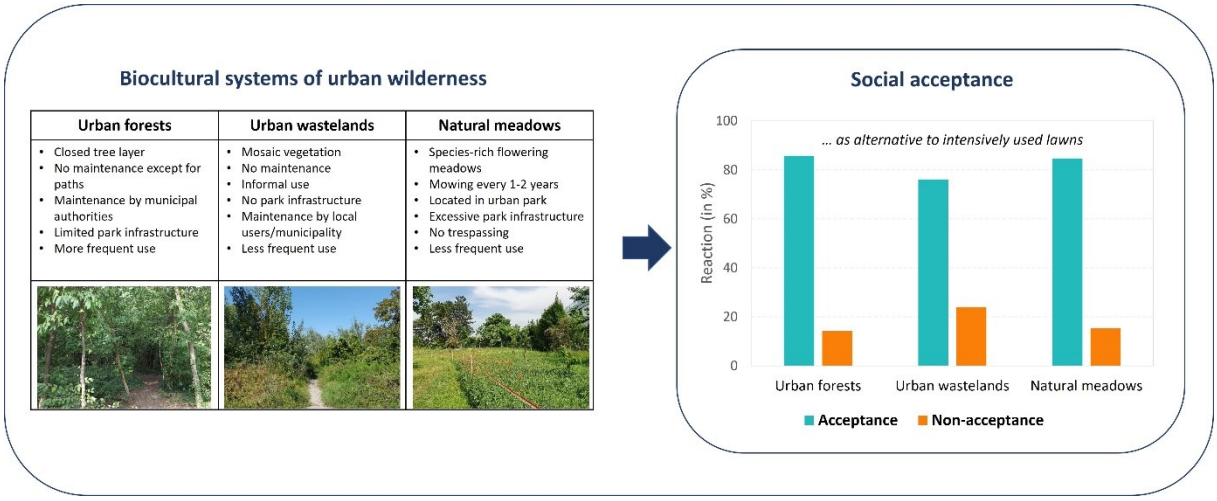

Fig. 10: Social acceptance for the types of urban wilderness

The three selected urban wilderness types differ both from an ecological point of view and in terms of their management and use profiles. They thus offer different potential for sustainable urban development. Despite these differences, their importance was rated as consistently high by the survey participants, with urban forests and natural meadows being rated slightly higher than urban wastelands. All three types were especially valued for their potential for reducing surface temperatures, regulating air quality and contributing positively to biodiversity. The perceived advantages were considered much more important than the disadvantages. Disadvantages frequently mentioned in the literature such as lack of attractiveness, promotion of invasive species or lack of protection against anti-social behaviour were perceived as important by only a few respondents.

To identify the social acceptance of urban wilderness areas, the survey participants were offered two different baseline situations and three scenarios – one for each type of urban wilderness area. In the

first baseline situation, the selected urban wilderness types would replace half of an intensively used meadow in an urban park. The second baseline situation envisaged the conversion of half of a new undeveloped urban area into each of the three urban wilderness areas. In all scenarios, there was unexpectedly high acceptance of the conversion into one of the three urban wilderness types by the respondents. Depending on the scenario, between 3 and 8 per cent of survey participants would actively resist the conversion and another 6 to 16 per cent would passively reject it. The remainder would either tolerate (11–16%), indifferently accept (12–18%), agree (38–50%) or consider active engagement (8–19%) to promote the conversion into one of the three urban wilderness types.

Of the three types of urban wilderness, there was slightly lower acceptance of urban wastelands, as they tended to be more often seen as unattractive, dangerous and an expression of neglect or lack of maintenance. Differences in the acceptance of urban wilderness areas were also found between different social groups. This was especially true for urban forests and natural meadows. Here we found that especially people under 25 years, with a lower level of education, from non-EU countries and people with children valued and accepted these two urban wilderness types less than other social groups. Interestingly, some of these groups tended to use urban wilderness areas more often, but valued them less for their contributions to biodiversity and the urban climate.

The present project results point to a great societal potential for protecting and promoting all three types of urban wilderness areas in Vienna. Their high acceptance and different ecological and social benefits offer possibilities for adapting urban wildernesses to the diverse socio-ecological conditions of the city and the needs of its inhabitants. With the three types of urban wilderness available, the city administration has a broad repertoire at its disposal to give space to spontaneous nature development processes in Vienna and to use them as nature-based solutions for a variety of social challenges.

StartClim2021.I: Modelling water demand for green walls (MEADOW)

Vertical greening systems (VGS) or green walls are versatile nature-based solutions (NBS) that respond to a wide range of challenges in urban water management, while mitigating effects of climate change. For example, they can be used for decentralized greywater treatment and at the same time for providing a cooling function for the outdoor environment. Thanks to their vertical design, these multifunctional NBS can be used not only in existing residential structures but also in new building developments.

Fig. 11: Green wall, photo: S. Handl (2020)

For their full potential to be developed, the design, size and the VGS must be adapted to the installation site and desired function(s). Adequate irrigation is key to full functionality. Unlike other NBS, such as green roofs, the irrigation requirements of VGS have not been studied in great detail, let alone modelled.

The goal of the project "MEADOW - Modelling the water requirements of green walls" was to close this gap by using machine learning principles based on available data.

For that purpose, a model for predicting the water demand of VGS was developed on the basis of measurement data from an experimental system in operation since 2020 at the University of Natural Resources and Life Sciences, Vienna (BOKU) in cooperation with the Graz University of Technology (TU Graz).

The model is suitable for estimating the water demand of VGS as a function of weather forecasts and climate projections. This allows planners and project developers to estimate the demand and thus to dimension systems for the storage of greywater and rainwater. In addition, the model could be used to determine which metering systems are suitable for effective instrumentation and irrigation control.

This water use model represents a first step toward the systematic and sustainable use of VGS, adapted to the environmental conditions at the installation site. The underlying methodology and the findings from MEADOW can be used by decision-makers to promote the use of green walls of all kinds with the involvement of stakeholders. By quantifying the performance, the models can also be used as a basis for discussing the benefits of VGS in general.

VGS could be used systematically as an effective tool to combat the negative consequences of climate change (e.g., reducing urban heat islands) and to establish them as an essential element of concepts for integrated urban water management, for example as measures for greywater and storm water management.

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