New Impulses for the Austrian Climate Change Adaptation

Final Report Part 1

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Abstract

StartClim has been studying adaptation to climate change since 2008. The projects in StartClim2018 addressed various research questions in connection with Land Use and Conflicts of Use in Climate Change, Climate change and communication, Climate change and art, as well as Educational research on climate change.

New drought-tolerant pulses for Eastern Austria

Pulses for human nutrition only cover a small area in Austria, even if the consumption of pulses is risingA higher range of leguminous crops in crop rotations would bring numerous advantages – a lower requirement of synthetically fixed nitrogen, lower emissions of N2O, and a positive effect on following crops. If more vegetables are consumed instead of animal products, climate-wrecking gases caused by animal production and the demand on fodder will decrease. However, the production of pulses is risky for the farmers. Due to climate change, traditional pulses as peas and green beans suffer from yield reductions because of low tolerance to heat and drought. So, more and more farmers show interest in heat and drought tolerant pulses as chickpeas, lentils, chickling peas and special bean varieties. Nevertheless, in Austria neither breeding nor propagation nor variety trials exist. To make a first step, two variety trials were conducted in the frame of StartClim, to compare different pulse species and varieties. 40 cultivars of Phaseolus-beans were sown on the farm Lerchenhof in Kamptal/NÖ, 26 cultivars of chickpeas, lentils, chickling peas and determinate growing Phaseolus-beans (Phasolus sp., Vigna sp.) were sown on the experimental farm of BOKU in Gr. Enzersdorf/NÖ. In Gr. Enzersdorf, chickling peas and chickpeas (both Kabuli and Desi types) were growing well. The lentil varieties differed much in yield what is ascribed to the different reactions on heat during flowering and ripening, and also to the imprecise harvest time. Chickling peas and chickpeas had higher average yields than beans and lentils. Among the beans, the breeding line ‚VAX 1' and the variety ‚Black Turtle' were most successful. On the farm Lerchenhof, mice damaged the first sowing and parts of the second sowing. Only small-seeded and early-ripening types – mainly varieties from Middle America - fully ripened. Favorites were ‚VAX 3', ‚Schwarze Bohne Brasilien', ‚Filetbohne Nicaragua', ‚Gelbe Feld' and ‚Weiße Bohne Schmidt', in addition to some Croatian, Hungarian and German landraces. As a conclusion, even it suitable cultivars exist, there are numerous risks for farmers to grow pulses: on the one hand, lack of knowledge about growing technology, on the other hand, low prices and lack of markets for high-pricing Austrian products. In order to meet these risks, further production trials were drafted and first steps for a pulse network were made. Financial and structural support should come from the public, according to the German protein plant strategy and demonstration networks for legumes. Further, production and marketing of pulses for human consumption should be promoted with different ÖPUL-measures (Austrian Rural Development programme). „Support of breeding of open-pollinating cultivars", stated in the government programme, should be realized.

The impact of different diets on climate change and land use in Austria as well as overseas (DIETCCLU)

Nutrition plays a central role in human health. Current average diets in Austria cause very high greenhouse gas (GHG) emissions and many other negative environmental effects within Austria as well as in other countries (e. g. in South America and Southeast Asia via soya and palm oil imports). The goals of the project DIETCCLU include the calculation of GHG emissions as well as the land requirement of different diets (current/average, significantly healthier according to ÖGE/DGE recommendations, vegetarian and vegan according to Gießen food pyramids). By changing from an average omnivorous diet in Austria causing 1,467 kg CO2-eq emissions/person/year, to a significantly healthier diet (66% less meat), 28% of GHG emissions can be saved. Vegetarian and especially vegan diets lead to even higher GHG savings of 48% resp. 70%. These reduction potentials are very similar with regard to the land requirement: The lowest demand of land for food is required for a vegan diet with 629 m2 per person per year (-66%).

Furthermore, an ovo-lacto vegetarian and a healthier diet according to ÖGE saves 42 resp. 32% compared to an omnivorous, average diet. This reduced land requirement which is significantly increased by organic products (organic vegan -76%, organic ovo-lacto vegetarian -57%, organic ÖGE -41% and organic omnivorous -18%) is mainly due to the reduced or non-existent proportion of animal products. A plant-based or a major meat-reduced, but particularly a well-planned ovo-lacto vegetarian or vegan diet can also significantly reduce the risk of cardiovascular diseases, diabetes mellitus type 2, hypertension and colorectal cancer. Based on the results, recommendations for the establishment of a sustainable and resource conserving diet can therefore be derived:

- Promoting vegetarian and vegan nutritional options
- 50% reduction in the consumption of meat (particularly pork and chicken)
- Measures to increase the holistic meat quality, aligned to strict sustainability criteria (significant GHG savings through organic meat)

Transform_T Tourism_Communication_Environment_Climate

This research project focused on the question of how actors from different levels and sectors in tourism can work together more efficiently in order to be better prepared for ecological challenges such as climate change, climate protection and land use Our lives and economies are increasingly confronted with ecological challenges and we recognize that ecological, but also social problems can have a negative impact on our economic system. This is the challenge we face as a society, as an organization and as individuals. The effects of climate change, the rapid reduction of greenhouse gas emissions and the associated land-use conflicts have also been addressed in the dialogue process on the tourism master plan. The main question here was how tourism stakeholders can better communicate and cooperate in order to respond effectively to these ecological challenges The research project first identified the interfaces of ecological challenges for the tourism sector, divided into the three fields of action, climate change adaptation, energy system transformation and changes in land use. This was done by analysing the content of various national strategies and technical recommendations of relevant institutions and completed projects However, the implementation of possible measures at regional level requires both conscious communication and a supportive framework. Therefore, the identified fields of action of the examined strategies, the framework conditions of communication structures, competencies and responsibilities, information measures and cooperation possibilities were compared in a matrix. In a one-day workshop in the tourism destination Salzkammergut, the social interactions required to bring the fields of action and measures defined in the strategies to the regional level and implement them were discussed together with regional actors. The compilation with the social science literature underpinned the chosen approach, in particular to include structures and networks of relationships, since only through social action recommendations for action from higher-level strategies can be implemented regionally. The aim of the project was to create a model example out of the synthesis of the theoretical work and the workshop that can serve as an orientation for an efficient communication and interaction in the implementation of sustainability issues in tourism destinations. It has become clear that the implementation of sustainability issues at regional level can be supported above all by adequate structures and clearly assigned roles:The result of the project is a model example of efficient communication of the contents of higher-level strategies to the local and regional tourism level. Of course, the model - according to its definition – can not be seen as a "recipe" for the implementation of sustainability issues. However, it provides useful guidance on as to which parameters are decisive for successful implementation:

- New, adapted and clear roles.
- Good communication skills.
- Adequate structures and networks.
- Common positive vision.
- New culture of cooperation in the tourism sector.

CLIMSchool 21– Can online learning formats and Citizen Science impart climate research to school students and raise their climate - friendly behavior?

There exists a gap between the general knowledge about climate change and sustainable climate-friendly behavior, especially among young people. The project CLIMSchool 21 aimed at (1) increasing the level of knowledge and understanding of middle and high school students about the consequences of climate change and (2) promoting climate-friendly behavior by using the specific example of "Effects of climate change on our waters". The main goal was to examine whether an extended, active engagement with topics surrounding climate change could achieve a better understanding and climate-friendly behavior than a short, passive engagement. The active engagement comprised the development of online quizzes, games, and videos, while passively involved students tested these tools. Using standardized questionnaires, all students involved were asked facts about climate change, their perception of climate change impacts, and their climate-friendly behavior before and after the project activities. Modern learning formats were found to be well suited for dealing with climate change aspects and for motivating students to intensively engage with the topic. The questionnaire results revealed that a general knowledge about climate change and climate awareness exist among the students surveyed, and that more than 90% believe that every single person can contribute significantly to tackle climate change. However, students had problems with understanding complex relationships and long-term interactions of the consequences of climate change on people and ecosystems, for example seeing the hidden water in everyday products. In that regard, the differences between active and passive approaches were small. Modern educational concepts should foster system understanding and seize on the young people's positive attitude towards climate protection by pointing out concrete, climate-friendly ways of behavior. In this way it is possible to strengthen the young people's believe in their actions (self-efficacy) and to reduce the gap between attitude and action.

Water Efficient Arable Farming – Communication of Topical Research and Practical Strategies on Climate Change Adaptation to Agricultural Schools and Farmers

Due to global warming, more frequent weather extremes are to be expected in Austria. This poses a major challenge to agriculture when, in dry summers, water becomes a scarce resource on the one hand, but on the other hand expected intensive precipitation events lead to severe soil erosion and all its negative consequences. These changed conditions make it necessary to bring soils into their best possible condition to meet the challenges. One objective must be to implement a combination of measures to prevent soil erosion, increase the water storage capacity of soils and avoid unnecessary water losses. Specific educational programmes are needed to prepare farmers for climate-related changes, but also to emphasize the need for action. In the project an educational concept for farmers and agricultural teachers was developed and relevant contents were defined. For a review external persons from the field of education and applied research were consulted. Farmers were also interviewed about the measures they use to adapt to climate change and their knowledge and experience were taken into account. The educational content was planned as a three-day course and prepared for implementation. The four topics, climate, soil, plants and measures for a water-efficient farming are dealt with regard to the soil- and plant water balance. The emphasis lies on measures and farmers' best practice examples. These include careful soil cultivation, soil cover through greening or mulching, the promotion of soil life, soil structure, humus enrichment, a diverse crop rotation system and the use of adapted crops and varieties. In addition to scientists, experienced farmers will also participate in the course as speakers. Spe-

cial attention was paid to the practice-oriented preparation of the educational content. The central pedagogical element is the "making comprehensible" of processes by use of simple field methods, experiments and demonstration objects. In this way, the complex interrelationships of soil-plant-water balance-climate will be explained to the course participants and will provide them with a "tool" which they can use on their own farm under the given site conditions. The holistic transfer of knowledge should also encourage further thinking in order to find alternative solutions for future challenges.

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 State 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 five StartClim2018 projects examined different aspects of relevance to climate change adaptation in Austria. The topics explored were:

- Drought-tolerant pulses
- Impact of different diets on climate change and land use
- Climate - friendly behavior in students
- Climate communication for Tourism
- Climate Change Adaptation to Agricultural Schools and Farmers

The StartClim2019 report consists of an overview of the results in German and English along with separate documentation containing detailed descriptions of the individual projects by the respective project teams. All StartClim2019 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.

StartClim2019.A: New drought-tolerant pulses for Eastern Austria

Pulses for human nutrition only cover a small area in Austria, even if the consumption of pulses is risingA higher range of leguminous crops in crop rotations would bring numerous advantages – a lower requirement of synthetically fixed nitrogen, lower emissions of N2O, and a positive effect on following crops. If more vegetables are consumed instead of animal products, climate-wrecking gases caused by animal production and the demand on fodder will decrease. However, the production of pulses is risky for the farmers. Due to climate change, traditional pulses as peas and green beans suffer from yield reductions because of low tolerance to heat and drought.

So, more and more farmers show interest in heat and drought tolerant pulses as chickpeas, lentils, chickling peas and special bean varieties. Nevertheless, in Austria neither breeding nor propagation nor variety trials exist. To make a first step, two variety trials were conducted in the frame of StartClim, to compare different pulse species and varieties. 40 cultivars of *Phaseolus*-beans were sown on the farm Lerchenhof in Kamptal/NÖ, 26 cultivars of chickpeas, lentils, chickling peas and determinate growing *Phaseolus*-beans (*Phasolus* sp., *Vigna* sp.) were sown on the experimental farm of BOKU in Gr. Enzersdorf/NÖ.

In literature, cowpea, chickpea and chickling pea are described as much more drought tolerant than pea. This is explained by larger root systems and more heat-tolerant rhizobia. Chickpeas and chickling peas develop fast and bring also high yields in hot summers, because seed development is finished when it is getting hot. In contrast, *Phaseolus*-beans flower and ripe in summer, and need relatively much water.

In Gr. Enzersdorf, chickling peas and chickpeas (both Kabuli and Desi types) were growing well. Regarding the chickling peas, the Austrian landrace ‚Bad Fischau' and the Italian landrace ‚Marchigiana' can be recommended. Regarding the chickpeas, the French Kabuli-variety ‚Ares' and the landrace ‚Cece nero' from Apulia/Italy had the highest yields. The lentil varieties differed much in yield what is ascribed to the different reactions on heat during flowering and ripening, and also to the imprecise harvest time. The French green lentil variety ‚Anicia' yielded best. Chickling peas and chickpeas had higher average yields than beans and lentils. Among the beans, the breeding line ‚VAX 1' and the variety ‚Black Turtle' were most successful.

On the farm Lerchenhof, mice damaged the first sowing and parts of the second sowing. Due to the late sowing date Middle of June the trial was irrigated, that's why there are no results on the drought tolerance. Early cultivars were fully ripe Middle to End of October. Late cultivars were only ripening partially. Given these circumstances, small-seeded and early-ripening types had the highest yields, among them again the bush beans ‚Black Turtle' and ‚VAX 1'. The breeding line ‚VAX 3', and the cultivars ‚Schwarze Bohne Brasilien' and ‚Filetbohne Nicaragua' performed well because of early ripening and excellent plant vigour. Further cultivars of interest were the Austrian landraces ‚Gelbe Feld' and ‚Weiße Bohne Schmidt' (both with indeterminate growth) and several Croatian, Hungarian and German origins. The lima beans did not ripe at all, based on the late sowing.

As a conclusion, even it suitable cultivars exist, there are numerous risks for farmers to grow pulses. The risks and potentials of an extended production and consumption of pulses were discussed on a field day in July 2019. As potentials were declared: the trend to vegetarian food, mulch seed sowing and mixed cropping systems, cultivars which can be used both as fodder for animals and for humans. As risks were declared: insufficient choice of cultivars, lack of knowledge about growing technology, low prices and lack of markets for high-pricing Austrian products. In order to meet these risks, further production trials were drafted and first steps for a pulses' network were made. Beside from the cultivar choice and the seed quality assurement it will be essential to optimizie the seed and harvest technique. A possible soil-conserving sowing method with a high weed-suppression is the Rodale Roller Crimper Method.

We recommmend following measures to introduce new crop species and cultivars:

1. Further exact field trials on experimental farms, with consolidation of retailers, gastronomists and consumers
2. The best cultivars will be spread on farms in different Austrian regions → on-farm trials and seed multiplication
3. Exchange among farmers (2 kg permitted for beans, no regulations for chickpeas, lentils and chickling peas) → Further seed multiplication on more farms, exchange in the pulse network

4. Involvement of retailers: small portions for homegardeneres via Arche Noah, larger portions for farmers via seed companies

Financial and structural support for building up these supply chains should come from the public, according to the German protein plant strategy. For realizing the biodiversity strategy, an office should be installed, bringing together environmental and agricultural policies. The already started collaboration among different institutions is a factor of success; but initial funding is needed in order to bring the pulse network to life. In Switzerland and in Germany, current demonstration networks and breeding programmes can be seen as good examples. Such strategies should be allocated to more drought tolerant legumes, divided fairly between numerous crop species. Further, production and marketing of pulses for human consumption should be promoted with different ÖPUL-measures (Austrian Rural Development programme). „Support of breeding of open-pollinating cultivars“, stated in the government programme, should be realized.

Fig. 1: Field-day „Pulses for human consumption“ in Gr. Enzersdorf in July 2019 – Visit of the experimental field

StartClim2019.B: The impact of different diets on climate change and land use in Austria as well as overseas (DIETCCLU)

Food consumption has a major impact on human health. Additionally, nutrition habits affect climate change, resource use, biodiversity, as well soil and water quality on a large scale. Current nutrition habits in Austria cause particularly high greenhouse gas (GHG) emissions and several further negative environmental effects, but also associated to land use, especially overseas (likewise South America and South-East-Asia via soy feed and palm oil imports).
The objectives of the project DIECCLU include the calculation as well as a comparison of the GHG emissions of different diets along the entire life cycle of consumed food products. Thereby the average Austrian diet is compared to the healthier diet recommendations of the Austrian society for nutrition (ÖGE), an ovo-lacto vegetarian and a vegan diet, according to the Gießener food pyramids.

Main results:

1) The current average omnivorous diet in Austria (OMNI IST) causes a total of 1,467 CO_2-eq emissions per person per year. By changing to a significantly healthier diet (adapted to the guidelines of the ÖGE; 66% less meat), 28.2% of GHG emissions can be saved (see Fig. 1). The reason for the lower GHG impact lies in the significantly lower proportion of meat and sausage products in the diets (which have a high CO_2 footprint).

2) An ovo-lacto vegetarian diet causes 767 kg CO_2-eq emissions/person/year and thus saves 47.7% of the GHG emissions compared to the OMNI IST diet. The greatest potential for GHG savings can be achieved by changing to a vegan diet with only 439 kg CO_2-eq/person per year, which corresponds to a saving of 70.1% of GHG emissions. The great saving potential of vegetarian diets in terms of GHG (but also in terms of land requirements, see below) is mainly due to the reduced or non-existent proportion of animal products.

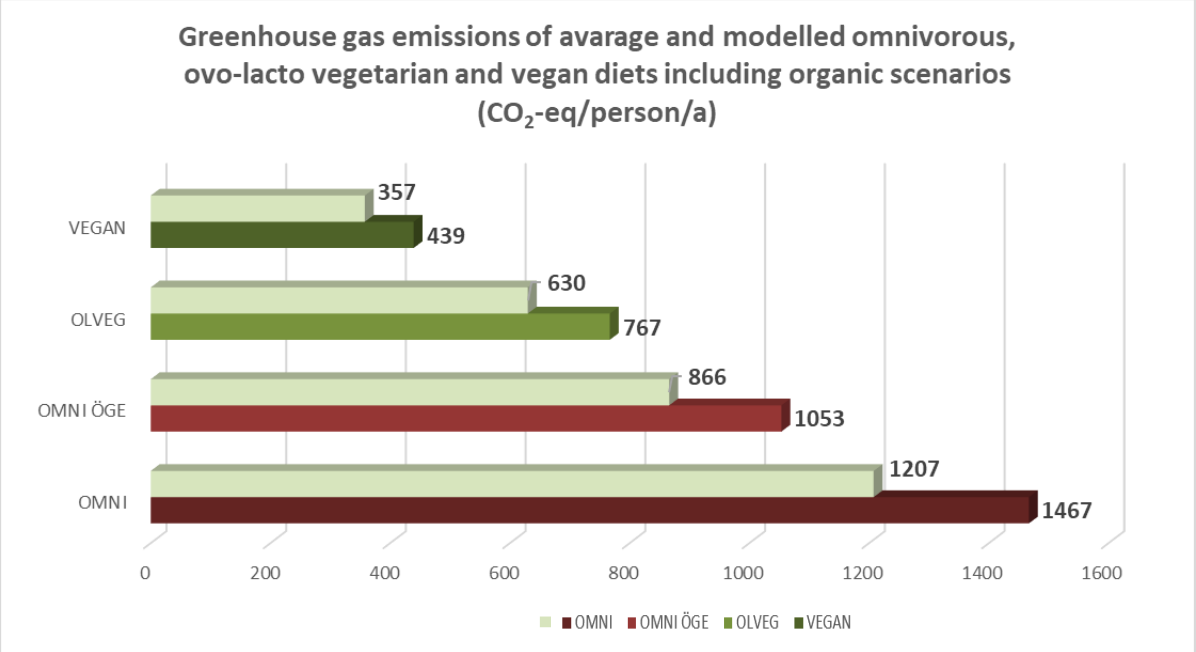

Fig. 2: Greenhouse gas emissions of average and modelled omnivorous, ovo-lacto vegetarian and vegan diets (own presentation), OMNI (dark red) = omnivore resp. average diet in Austria, OMNI ÖGE (red) = according to the recommendations of ÖGE, OLVEG (green) = Ovo-Lacto Vegetarian according

to ovo-lacto vegetarian Gießener food pyramid, VEGAN (dark green) = according to vegan Gießener food pyramid, respective BIO light green = ORGANIC scenarios

3) These positive environmental effects are further significantly increased by a 100% organic product share in all nutritional options studied (organic vegan -76%, organic ovo-lacto vegetarian -57%, organic ÖGE -41% and organic omnivorous -18%), (see Fig. 2), as organic agriculture in Austria also reduces GHG emissions per unit (kg) of product for most foods, especially meat and eggs.

4) Regarding the different diets and their saving potential in terms of land use the picture remains similar. An average omnivorous diet requires the largest land demand of all diets amounting to 1832 m^2 per person per year (see Fig. 3).

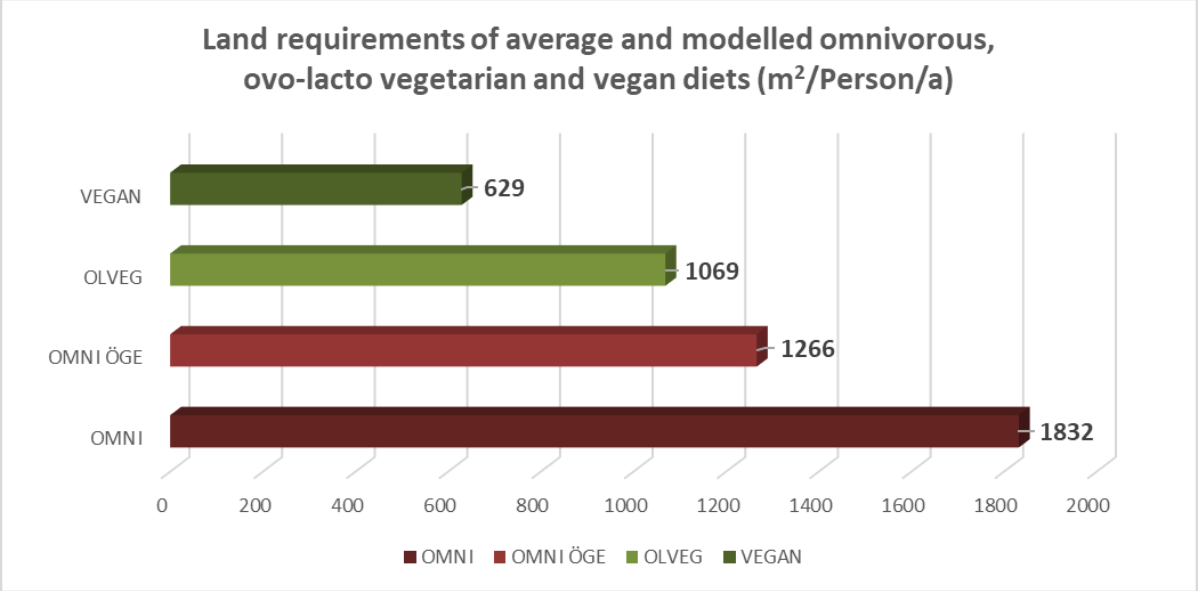

Fig. 3: Land requirements of average and modelled omnivorous, ovo-lacto vegetarian and vegan diets (own presentation), OMNI (dark red) = omnivore resp. average diet in Austria, OMNI ÖGE (red) = according to the recommendations of ÖGE, OLVEG (green) = Ovo-Lacto Vegetarian according to ovo-lacto vegetarian Gießener food pyramid, VEGAN (dark green) = according to vegan Gießener food pyramid

On the contrary, the least land requirement for food production is needed for a vegan diet with 629 m^2 per person per year. This corresponds to a saving potential of approximately two thirds of the land use (65.7%) compared to the average diet in Austria, which also gives the greatest potential for savings. An ovo-lacto vegetarian diet approximately reduces the impact on land use for food by 41.7% of the land compared to the average diet per year and person – and a diet according to the ÖGE recommendations saves 30.9% of the total land demand.

5) In addition, spill-over effects on land use abroad can be reduced, if meat consumption is cut and thus soy feed imports are significantly reduced. Furthermore, a reduction in meat consumption of -33.5% would mean that enough land (314,466 ha) would be freed up, that theoretically all currently imported soy feed and imported palm oil could be replaced in Austria in the form of the cultivation of soy, rapeseed and sunflower.

6) According to the United Nations, a change to healthier, considerably meat reduced diets could prevent 11 million deaths worldwide each year as a result of malnutrition. Choosing a well-planned ovo-lacto vegetarian or vegan diet can significantly reduce the risk of cardiovascular disease, diabetes mellitus type 2, hypertension and colorectal cancer.

In September 2019, Austria officially declared a climate emergency. In order to reduce GHG emissions in accordance with the Paris Agreement and at the same time creating important co-synergies for health, biodiversity, soil and water protection as well as for food security, appropriate meat-reduced diets should be established and corresponding measures should therefore be taken at all levels.

Based on the results, recommendations for the establishment of a sustainable and resource conserving diet can therefore be derived:

- Promoting vegetarian and vegan nutritional options
- 50% reduction in the consumption of meat (particularly pork and chicken)

  Measures to increase the holistic meat quality, aligned to strict sustainability criteria (significant GHG savings through organic meat)

StartClim2019.E: Transform_T Tourism_Communication_Environment_Climate

This research project focused on the question of how actors from different levels and sectors in tourism can work together more efficiently in order to be better prepared for ecological challenges such as climate change adaptation, energy transition and land use (BMNT 2019).

Our lives and economies are increasingly confronted with ecological challenges and we recognize that ecological, but also social problems can have a negative impact on our economic system. This is the challenge we face as a society, as an organization and as individuals. We must try to compensate for this imbalance (disparity) into which we are manoeuvring and to bring economic, ecological and social actions into balance. The 17 sustainability goals of the United Nations - Sustainable Development Goals, SDGs clearly illustrate the direction in which we should go.

With "Plan T", a strategic basis for the future of domestic tourism was developed, which aims to put Austria on the path to becoming the most sustainable tourism destination worldwide. In order to achieve this, the people and their habitats have to be placed in the center of attention. The dialogue process on the Master Plan Tourism also dealt with the effects of climate change, the rapid reduction of greenhouse gas emissions and the associated land use problems. This raised the question of how actors from different levels and sectors in the tourism sector can better communicate and cooperate in order to respond more effectively to these ecological challenges (BMNT 2019).

In order to identify the fields of action and thus the interfaces between the ecological challenges and tourism, a content analysis of national strategies and technical recommendations of relevant institutions (ÖROK; BMNT) as well as completed projects (ACRP; StartClim) on climate change adaptation, climate protection and land use was carried out. In addition, the strategies were screened for communication and networking measures and structures. The results of the content analysis were summarized in a matrix. It is evident that the strategies only make vague statements about how goals should be communicated to regional actors.

The literature research was adapted and supplemented during the course of the project and summarizes general findings on communication and social interaction. In the beginning, the project focused on "efficient communication and networking measures". However, it quickly became clear that structures and networks of relationships in particular had to be included, since recommendations for action of higher-level strategies can be implemented regionally only through social action.

On 23rd January 2020 a workshop entitled "Kommunikation MitWirkung" was held in Bad Goisern with actors from the tourism destination Salzkammergut. Guided by questions such as how to involve stakeholders, the effectiveness and practicability of methods of communication and cooperation, as well as incentive systems to move from talking into action, the results of the content analysis were reflected. The practical experience of tourism professionals has shown how trust-building and solution-oriented communication and interaction can work and how tourism destinations and tourism businesses can identify and pull off effective ”levers” to initiate necessary action. Seven recommendations for tourism regions could be extracted from the workshop results:

Seven recommendations for tourism regions could be extracted from the outcome of the workshop:
1. Motives, values, attitudes are crucial.
2. Build on information and facts.
3. Enter into communication and interaction.
4. Continue sensitization and motivation continuously.
5. Create a common vision.
6. Practice habitat management.

7. Clarify the organizational framework conditions.

The results from content analysis, literature research and those from the workshop were summarized and a model of efficient and effective communication for tourism destinations in dealing with ecological challenges was developed. The aim of the model example is to provide orientation for tourism destinations beyond the case study region. Furthermore it should support the reflection on communication and networking structures and to set impulses, as well as to adapt, adequately build or strengthen appropriate structures to current regional issues.

These are prerequisites for effectively communicating the contents of overarching sustainability strategies in tourism destinations:

1. **new, adapted and clear roles**

There is a need for self-confident actors in the regional tourism associations who can act as role models and authentically communicate sustainability issues. An essential characteristic of the holders of these roles is their new understanding of tourism organizations. They distance themselves from the idea of a tourism association as a marketing agency, but see themselves as designers of a habitat organization.

In addition, mediators are needed at the federal province level to filter and process the essential points of higher-level strategies and to pass them on to the corresponding actors at regional and local level.

2. **good communication skills**

People who slip into this creative role should know and implement the basic principles of communicating sustainability issues.

3. **appropriate structures and networks**

Social action - the implementation of sustainability issues is social action - can only be made possible through the coordination of activities in time and space. Actions in the sense of sustainability can be coordinated only through social interaction. A strategy alone is not enough and social interactions can not be attributed to the intentions of a single actor. Negotiations are necessary, the exchange of resources, information, services, symbols etc. is needed. These activities should be actively encouraged and supported, including in financial terms.

4. **common positive vision**

Shaping the future depends on meaningful cooperation between people. A vision that shows how this can be made possible may act as a catalyst. Backcasting approach can be used to show solutions to this positive vision.

5. **a new culture of cooperation in tourism**

Culture, in other words common values, convictions, beliefs or orientations, is the glue that binds social units. As a result it should be considered whether a new culture of cooperation in tourism sector is conceivable or feasible. Culture is nothing rigid, even if it often seems so. Values, social norms and social roles are phenomena that refer to each other. Together they offer orientation for those involved.

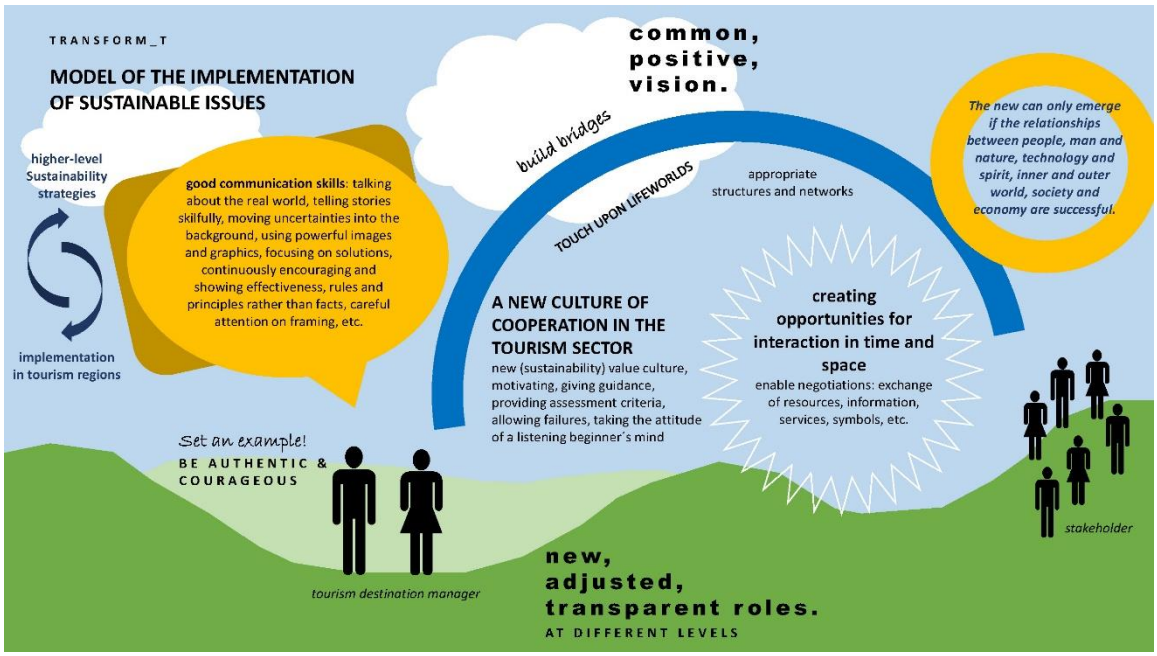

Fig. 4: Model of the implementation of sustainability issues.

StartClim2019.G: CLIMSchool 21– Can online learning formats and Citizen Science impart climate research to school students and raise their climate - friendly behavior?

Numerous studies and survey results indicate that the majority of the population is aware of climate change and displays worries about it (EC, 2017, 2019), but only a few people show willingness to change their behavior accordingly and to act more climate friendly (Barr, 2006). The discrepancy between knowledge and action (value - action gap) is seen as an obstacle to successful adaptation to climate change (Gifford, 2011), and is particularly pronounced in the young population group (EC, 2019). In addition to the lack of a sound basic knowledge (Corner, 2015), young people above all lack the believe in their own possibilities and the conviction that their actions are enough to achieve something ("bigger than self-dilemma", Wibeck, 2014).

The research - education - cooperation project CLIMSchool 21 reached out for young people through educational institutions and tried to motivate them to engage intensively with climate change and to act in a climate-friendly manner. Modern teaching and learning formats were used in order to contrast to the typical "learning" at school, to impart positive messages and solutions, to challenge students to voluntarily engage with the topic, and to emphasize the self - efficacy of their actions (Chiari et al., 2016, Corner et al., 2015). The aim of the project was to examine, whether a longer-term, active engagement with topics around climate change can achieve a greater effect on the understanding of complex relationships and raise climate-friendly behavior more effectively than a short, passive learning phase. Furthermore, the project tried to identify the climate change aspects causing the biggest problems in understanding, and tested which formats are well suited for conveying the topic.

Using the example "Effects of climate changes on our waters", the project team actively engaged with five "active" and 2 "passive" project groups at 4 different schools in Vienna and Lower Austria (High schools BG/BRG3, Vienna, Radetzkygasse and BG/BRG Wieselburg: 10th and 11th grade, and middle schools: NMS Lunz and NMS Ybbsitz: 7th and 8th grade). During an introductory workshop at the schools, project team members gave an overview of the effects of climate change in general and on water bodies in particular, focusing on the situation in Austria and on water bodies in the immediate vicinity of the students. After this introduction, the school students got the task to prepare information on climate change impacts as well as suggestions for climate-friendly behavior as attractive as possible for peer students. The students were free to choose their preferred (teaching) format. In small groups, the "active" students worked on the development of their formats over a longer period of time as part of project lessons dedicated to the CLIMSchool project. This work resulted in several online quizzes (created with "Kahoot!", an online learning platform that allows the interaction of several devices connected to the internet), videos and (board-) games with different focus areas. Later, these formats were tested by other students of the same school, the so-called "passive" students", as part of peer learning events. Active students were also made aware of and encouraged to work with the citizen science app "CrowdWater", developed by the University of Zurich to collect hydrological data (www.crowdwater.ch).

With the help of an online questionnaire all involved students answered climate-relevant questions of the categories behavior, perception and knowledge before and after the activities. In addition to the general development of the students, the questionnaire results revealed special thematic aspects of climate change that are causing problems of understanding and are showing a lack of awareness. The evaluation of project activities and formats used was supplemented by the personal feedback of the students and teachers involved as well as the experience of the project team.

The before - after comparisons of the survey results (within the active and passive groups as well as the direct comparison of the active with the passive groups) showed a relatively small fluctuation range and only minor differences statistically, when all answers and categories are considered. The questionnaire evaluation indicated that the general level of knowledge and the climate awareness of the students were high, even before the project activities. The results also demonstrated that the project was

able to slightly increase the scores of active as well as passive students for the majority of the questions. The learning effect didn't seem to depend on the duration of the discussion, but rather on the quality of the discussion and engagement (see Figure 1).

The more detailed analysis of selected answers showed that many students are not aware that Austria is particularly affected by climate change. Only 23 % stated that climate change is more obvious in Austria than other countries (or the global average), and 12 % believed that scientists are still discordant whether or not climate change affects Austria.

The proportion of students who were convinced that each individual person can make a valuable contribution to protect the climate is, however, over 90 %. Generally, there is a positive consent regarding climate protection and the conviction that everyone is doing their part in saving the climate. Many of the surveyed students (> 70 %) reported that they walk as often as possible, take the bike, or use public transportation, and most students also answered that they consciously try to save and conserve energy (> 80 %). To protect our waters, many of the surveyed students report that they save water in the household (60 %) and mainly drink tap water (> 70 %).

Selected answers furthermore revealed that many students have problems understanding the complex interdependencies and interactions of the consequences of climate change on people and ecosystems. For example, it was difficult for students to correctly estimate virtual water consumption. While many were aware that the production of a pair of blue jeans requires a lot of water, they weren't aware that this is also true for the production of smartphones. Only a small fraction of students (7 %) knew that smartphones are the one out of four products named requiring the most amount of water in its production process (see Figure 2). Another noteworthy aspect was that the students were not aware of the social consequences of climate change. Only 3 % answered that the human-caused greenhouse effect is responsible for poverty increases in Austria. By dealing with these topics over the course of this project a small improvement of awareness could be reached.

Moreover, it was difficult for students to correctly assess causes and effects of water scarcity and desiccation. Through a targeted approach to the topic "Effects of climate change on our waters" the project was able to increase the understanding of these special aspects of climate change among the active group. Students of the passive groups did not deal with these topics specifically and had greater difficulties in understanding them.

The analysis of the survey responses and the individual responses of teachers and students suggest the conclusions that:

- ... educational concepts in Austrian schools should reinforce the basic knowledge of the consequences of climate change in Austria and the regional impacts. The knowledge of general facts must be complemented with knowledge of regional and country specific consequences, so that the spatial distance to visible and perceptible effects is reduced (strengthening the direct relation to daily life).
- ... the young population has a positive basic attitude towards climate protection, which should also be taken up in appropriate educational concepts in school. Demonstrating a number of alternative climate-friendly behaviors can motivate and increase the willingness to personally contribute to climate protection, as it reinforces the feeling of self-efficacy and supports climate-friendly actions.
- ... an increased system understanding through the demonstration of multidimensional, causal relationships must be granted more space in educational concepts in the future. In particular, the aspects of "virtual water consumption" and "social consequences of climate change" should be taken into account in sustainable education. The complex causes and effects of climate change impacts on Austrian waters could be taught as part of special project lessons.

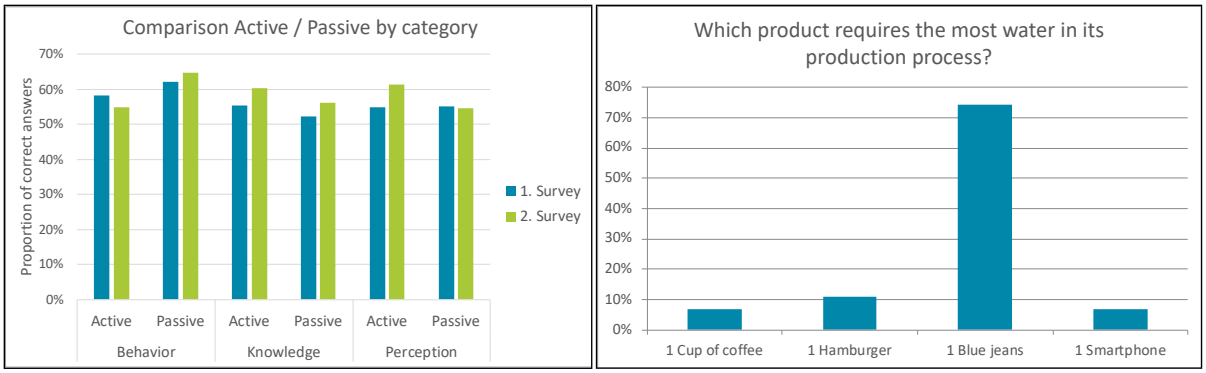

Fig. 5: before and after comparison of active and passive groups divided into the three question categories behavior, perception and knowledge. Right (2): Distribution of students'answers to the question "Which product requires the most water in its production process?"

StartClim2019.I: Water Efficient Arable Farming – Communication of Topical Research and Practical Strategies on Climate Change Adaptation to Agricultural Schools and Farmers

Due to global warming, more frequent weather extremes are to be expected in Austria. This poses a major challenge to agriculture when, in dry summers, water becomes a scarce resource on the one hand, but on the other hand expected intensive precipitation events lead to severe soil erosion and all its negative consequences. These changed conditions make it necessary to bring soils into their best possible condition to meet the challenges. One objective must be to implement a combination of measures to prevent soil erosion, increase the water storage capacity of soils and avoid unnecessary water losses. Specific educational programmes are needed to prepare farmers for climate-related changes, but also to emphasize the need for action.
In the project an educational concept for farmers and agricultural teachers was developed, relevant contents were defined and educational material prepared. The concept provides for a strong practical orientation, both in terms of content and implementation. A lot of attention was paid to the didactically appropriate transfer of knowledge on the subject, incorporating both, many years of experience in mutual exchange with farmers and innovative methods. For a review, external persons from the education sector (education experts of the LFI NÖ and a teacher of an agricultural school LFS) and applied research were consulted. Both a deepening of knowledge in soil cultivation measures and the use of demonstration objects and practical exercises in the course were highlighted as particularly suitable. Several innovative farmers from different regions in Eastern Austria were asked how they perceive the consequences of climate change on their land, which measures they consciously implement to adapt to climate change and which findings they can pass on. Among other things, all of them cited a reduction or change in tillage as a particularly important measure.

Literature research on current research results was conducted on the relevant educational contents. Practical exercises and suitable experiments were designed for the course. Educational material like presentations and articles were adapted, relevant films and demonstration objects were identified. Important methods for agricultural practice were compiled and corresponding instructions for an independent performance were created. A list of questions and answers concerning soil water balance and agriculture was compiled, which are also innovatively implemented in a soil game.

The educational content was planned as a three-day course and prepared for implementation. On the first two days, theory and practical exercises complement each other. On the third day practical exercises and demonstrations are carried out in the field, whereby the contents of the first two days will be deepened. The agricultural educational institution LFI NÖ has confirmed the acceptance for the 2021 course programme. In addition to speakers from research, experts from practice will also be involved, and various speakers have been confirmed. Farmers who are already implementing measures to adapt to climate change bring their experience to the course as "best practice" examples. In this way a direct implementation and linking of theory and practice takes place in cooperation between science and practice.

The course covers the four subject areas of climate, soil, plants and measures for a water-saving economy. All topics are dealt with in relation to the soil or plant water balance. The introduction discusses the influence of climate change on regional agriculture. Changes in temperature and precipitation are expected to cause a variety of interactions between soil water balance, humus content, soil structure and biological activity. The emphasis lies on measures and farmers' best practice examples. These include careful soil cultivation, soil cover through greening or mulching, the promotion of soil life, soil structure, humus enrichment, a diverse crop rotation system and the use of adapted crops and varieties. It is important that factors that can be influenced at farm level are also successfully implemented. That’s why special attention was paid to the practice-oriented preparation of the educational content.

The central element is the "making comprehensible" of processes by means of simple field methods, experiments and demonstration objects, as well as short films or an innovative soil game. The implementation can take place as a demonstration by a speaker or as individual/group work. The practical exercises are at the beginning of an educational content and are carried out by the participants as far as possible independently. These are, for example, the finger test to determine the soil type, experiments on infiltration and storage capacity in different soils also depending on the humus content, experiments on evaporation at different surfaces and environmental influences, importance of roots in relation to erosion and soil life among others. This stimulates the senses and emotions first. The corresponding theory is then dealt with and examples of practical applications are presented in more detail. In this way, information can be absorbed and anchored via several channels of perception. A networking of different knowledge contents and findings can take place. Attention and motivation to learn are also increased if concrete examples from practice are presented, which can also be implemented on one´s own farm or school. In the figure below, the course's educational trail with practical exercises, theory part and measures with best practice examples for the holistic transfer of knowledge is shown schematically. In this way, the participants will be introduced to the complex interrelationships of soil-plant-water balance-climate and will be given "tools" which they can use on their own farm under the given site conditions. The holistic, networked transfer of knowledge is also intended to encourage further thinking in order to find alternative solutions for future challenges.

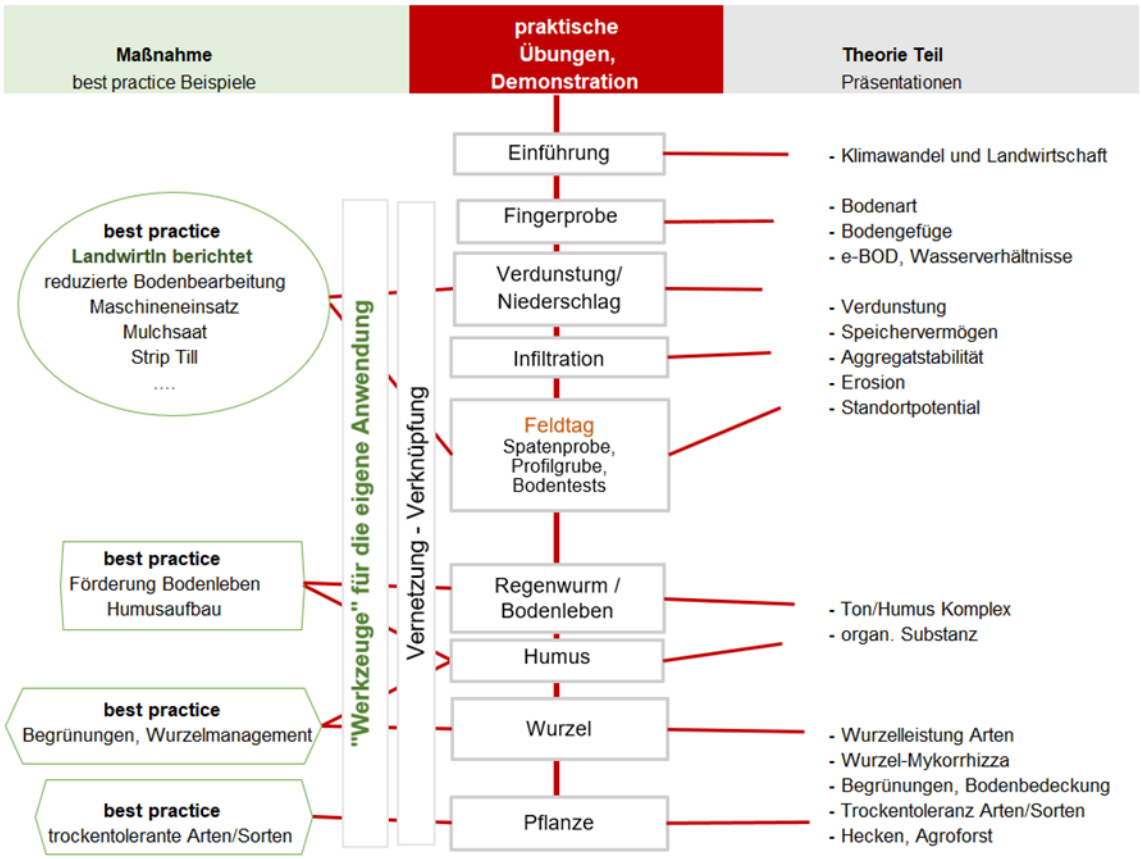

Fig. 6: The "educational trail " is presented in a simplified form as networking and linking of theoretical knowledge, practical exercises as well as experience and knowledge from practice. The holistic imparting of knowledge is intended to enable the best possible use as a "tool" for an application on one's own farm.

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