StartClim2016

Climate Change in Austria – Developing Additional Adaptation Strategies

Final Report

Project Leader
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Department of Water – Atmosphere – Environment
BOKU – University of Natural Resources and Life Sciences, Vienna
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Contracting Parties

Austrian Federal Ministry of Sustainability and Tourism
Austrian Federal Ministry of Education, Science and Research
Federal State of Upper Austria
Austrian Federal Forests
Federal Environment Agency

Administrative Coordination

Federal Environment Agency

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Abstract

StartClim has been studying the subject of adaptation to climate change since 2008. The projects in StartClim2016 addressed various research questions and provided scientific support for implementation of the Austrian Adaptation Strategy. Two projects focused on monitoring systems for nature conservation, one dealt with biogenic resources, one researched social transformation, one tested a way to monitor forest pests using an unmanned aerial vehicle, and one focused on the issue of migration in the context of climate change.

“Monitoring the effect of climate change on biodiversity” presents a concept for assessing the effects of climate change on biodiversity in Austria. The concept covers effects on habitats, species richness, diversity, distribution and abundance, and phenological changes. For this purpose, data sets from existing biodiversity monitoring programmes should be regularly analysed and complementary surveys on particularly relevant species groups initiated. The concept includes an overview of combinations of ecosystems and taxa, for which knowledge of climate change impacts is essential. Data sets, suitable approaches for their analysis and timeframes are presented for existing biodiversity monitoring programmes at the national level (GLORIA, ÖWI, BINATS, ÖBM-Kulturlandschaft, WRRL-Monitoring, FFH-Monitoring, Vogelmonitoring). In the course of the prioritisation of the ecosystems and taxa for which monitoring of climate change impacts are necessary, several ecosystem/taxon combinations were identified for which a new monitoring programme needs to be established: in the nival and alpine zones, the monitoring of vascular plants following the GLORIA approach should be extended to further Austrian mountain regions; vascular plants should be monitored in forests, and amphibians and dragonflies along rivers and lakes; mosses, vascular plants, trees, amphibians, dragonflies and habitat types in wet habitats and vascular plants, reptiles, snails, grasshoppers, butterflies, bees and habitat types in dry habitats. Protected species that have not been monitored so far should also be a priority target in all ecosystems. Priority should also be given to monitoring all protected species. The programme should be prepared in 2018/19 and implemented at five-year intervals from 2020 onwards.

Every year in Austria, thousands of amphibians are killed when crossing roads on their yearly spawning migration. As all amphibian species in Austria are endangered, amphibian fences are installed in highly frequented places, the animals collected in buckets and – after an inspection once or twice a day – carried safely across the road. The organisation of this volunteer work would be much easier if the beginning and end of the spawning migration could be predicted at least some days in advance.

The AmphiKlim project identified possible triggering factors for amphibian migration and plant phenological phases, which could serve as an early-warning system. Temperature in combination with precipitation was identified as the main trigger of amphibian migration. A mean daytime temperature of 3–6°C (cf. Kromp-Kolb et al., 2003; Münch, 1998) is seen as a threshold value for starting the amphibian migration. Precipitation promotes migration and is very important, especially with regard to the availability of spawning possibilities (water level of ponds, pools, temporary waters). Climatic changes could have the effect that the animals – although the temperature would be suitable – do not migrate at all or start to migrate later because of the absence of precipitation. According to expert interviews, this phenomenon can already be recognised phenologically in Austria in the form of delayed migration start and increasingly concentrated migration of individual amphibian species (species migrating simultaneously). Experts assume that drought will produce “climate winners” (green toad) and “climate losers” (common frog, agile frog) among the amphibians.

As regards the prediction of the migration start by means of indicator plants, a possible correlation could be investigated with the blossoming of hazel, spring snowflake and sallow. On average, the animals start to migrate about five days after the beginning of the first

blossoming (hazel nine days, spring snowflake five days, sallow two days) with possible large deviations dependent on the location.

The reliability of these findings is limited, as differences in the monitoring and processing of amphibian migrations in Austria have an adverse effect on the availability and quality of data. In order to allow for better confirmed and more precise statements on prediction and temporal development of the beginning of amphibian migrations, unified/standardised data collection (checklists) and an Austria-wide database would have to be introduced. The present study makes it appear likely that an improved database would produce sufficiently reliable statements about the use of indicator plants for the delimitation of migration times, and the additional documentation effort would therefore also be worthwhile for the volunteers. As with ongoing climate change, the indicator plants/phases could change – different species react at different rates to climate changes – the documentation would have to be continued and adapted with regard to possible indicator plants.

The interactions of future climate change, future production in agriculture and forestry and availability of areas to grow renewable raw materials for material as well as for energetic uses are investigated by several modelling studies with national scope within the forestry and agricultural sectors.

Scenarios, which take into account a strong climate signal, anticipate a substantial production decline within arable land. Increased competition for different land uses seem to be a logical consequence. The majority of modelling studies taking into account a moderate climate signal in respect to temperature increase predict increasing biomass production in Austria. While production decreases within the arable land, production increases within the grassland. Scenarios, which additionally presume a stop of payments for less favoured areas and ecological focus areas show major afforestations as a consequence. Supply of wood for material use and energetic use is even secured in scenarios taking into account a strong climate signal. Most severe production declines affect the eastern parts of Austria. If these production declines of food- and feedstuff are not compensated by imports, competition between different uses of agricultural goods will result according to the modelling studies.

The agricultural producers are mainly led by market situation and the policy on subsidies. The explicit goal of recent politics aiming on decreasing the dependency on imported fossil energy will not be reached without massively curtailing production of food- and feedstuff according to the simulations. For efficient use of limited agricultural area in the context of increasing material and energetic use of biomass future multiple cascadic uses of renewable raw materials will be of decisive importance.

One StartClim2016 study looked at two climate protection programmes, the e5 Programme for Energy Efficient Municipalities and Model Regions for Climate and Energy (KEM) of the Climate and Energy Fund. It focused on the need for awareness-raising as a contribution to a move towards climate-friendly behaviour, especially among decision-makers at the municipal level, and the experience of the actors involved in the implementation process. Both programmes share the goal of actively pursuing locally active climate policy and an understanding of awareness-raising as an integral component of the process. However, the starting point of the programmes and their implementation differs considerably. The main divergences identified were: their geographical focus (municipality vs. region), the specifications (catalogue of measures vs. free focus) and the financial resources (investment vs. access to funds). The analysis of the three case study regions (each one being a KEM and including e5 municipalities), showed that far from conflicting with one another, the programmes complement each other.

Four categories of awareness-raising measures were identified: public relations, the role model effect of local authorities, projects in educational institutions, and events and projects that engage citizens. In addition, the successful implementation of climate-friendly projects was described as the best awareness-raising instrument and the most likely to find imitators.

Both programmes, and others like Climate Alliance, have led to the creation of a readily accepted network facilitating the exchange or dissemination of information on successful events, projects and approaches among the participants.

A particular challenge is the long-term nature of awareness-raising activities, as well as the search for role models and the dependence on political support.

The most obvious effects in terms of awareness-raising could be found among those persons who – because of their active role in the programme – regularly dealt with the topics of energy saving and climate protection. This was especially true for programme working groups in the respective municipalities. For these people, the effect sometimes even went beyond pure awareness-raising and is already reflected in changed modes of action. However, neither KEM nor e5 are isolated, but embedded in international, national, regional and local efforts to address climate protection. The two programmes contribute to this with their respective focus of activities.

As a result of climate change, many forest ecosystems experience increased stress caused by higher temperatures and/or less precipitation. At the same time, extreme events like storms and strong winds occur more often, leading to a rise in pest infestations. In Central Europe the bark beetle population in particular is likely to increase in coniferous forests. They pose a great ecological and economic risk because of their rapid spread and the enormous damage they cause. It is therefore important to develop rapid and simple methods to monitor forests for early signs of infestation.

The growing need for rapidly available, reliable and comprehensive forest data has resulted in the increased use of remote sensing methods for forest monitoring. Up to now this data has been mainly based on satellite or airborne sensors, which have been providing increasing information of constantly growing quality. In recent years, a trend towards the use of unmanned aerial vehicles (UAVs) for data retrieval has been observed. These systems are flexible and provide data of very high spatial resolution. Because of their rapid operational readiness and flexible application, UAVs are ideal for identifying forest damage. This study focused on the possibility of UAVs to detect discoloured trees, and the use of different camera systems. The discoloration of spruce trees, weakened by the six-dentated bark beetle, starts in the tree crown. To detect this change, pictures taken with a commercial camera in the visible spectrum (red-green-blue, RGB) from a low-cost UAV reveal distinct advantages compared with time-consuming field inspections. The damaged trees are clearly visible from the air and their position is easy to locate with appropriate methods.

To compare different camera systems for their suitability for detecting loss of tree vitality, multiple cameras were mounted on one UAV to permit simultaneous image acquisition. Besides a commercial camera, multispectral and thermal cameras were tested. During the study period no additional bark beetle infestation was observed, so the study focused on spruce trees already damaged. The damaged treetops were best visible in data taken by a multispectral camera with six narrow spectral bands. When monitoring weakened trees, it is important to take specific differences between tree species into account. The formation of cons in firs can lead to changes in vegetation indices (combination of several spectral bands) or a spectral signature indicating the dying of needles. For single tree analysis it is thus advisable first to determine the tree species. A first analysis revealed that this is also possible with the acquired data.

A well-planned UAV operation could be of great assistance in silviculture. Depending on the equipment, UAVs could be used solely for the location of certain points or for a detailed analysis. This could be the differentiation of tree species or the detection of vitality changes. Thus, UAVs and applicable camera systems could be important tools for the additional monitoring challenge in forests resulting from climate change.

The relationship between climate change and migration has received increasing academic, political and public attention over the last few years. Climate change is associated with migration in many ways, and migration responses in this context are diverse and closely interlinked with social, economic, political and other aspects. This short-term research project summarised the state of research on migration scenarios in the context of climate change and their relevance for Europe and Austria, reviewing statistical data available for these scenarios and taking into consideration relevant social, economic and political aspects and inequalities.

The findings revealed that discussion continues on terminology and concepts capable of adequately covering this complex phenomenon. The first section therefore starts by briefly discussing the most important aspects in this context. In a second section, the most relevant migration scenarios are presented and discussed, with a specific focus on migration as a result of sudden-onset disasters such as storms, heavy rains and floods; long-term environmental change or degradation where migration is also understood to be an adaptation strategy; displacement caused by conflict associated with a degrading environment; and the issue of “trapped populations”. Research showed that migration responses associated with these scenarios are multifaceted, diverse, complex, context-specific and closely connected with the issue of inequality. Most movement in the context of climate change will not be international migration but rather internal movement. Migration dynamics in the direction of Europe are still not well understood. The last section discusses possible starting points for adaptation measures.

1 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 currently consisting of nine institutions:

- Federal Ministry of Agriculture, Forestry, Environment and Water Management
  (since 2003)
- Federal Ministry of Health
  (2005, 2006, 2007)
- Federal Ministry of Science, Research and Economy
  (since 2003)
- Province of Upper Austria
  (since 2012)
- Austrian Federal Forests
  (since 2008)
- Oesterreichische Nationalbank
  (2003, 2004)
- Austrian Hail Insurance
  (2003, 2004, 2006, 2007, 2008)
- Federal Environment Agency
  (2003)
- Verbund AG
  (2004, 2007)

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

The six StartClim2016 projects examined different aspects of relevance to climate change adaptation in Austria. The topics explored were:

- Assessment of the effect of climate change on biodiversity
- Impact of climate change on animal activity phases
- Biogenic resources and future risks and problems
- Awareness as a driving force for social transformation
- Detection of bark beetle infestation
- Migration and climate change

The StartClim2016 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 StartClim2016 reports and documents will be available for download on the StartClim website (www.startclim.at). A limited number of CDs containing all StartClim reports and a folder with a short summary of the results will also be made available.

2 StartClim2016.A: Monitoring to assess biodiversity effects of climate change

This project presents a concept for assessing the impact of climate change on biodiversity in Austria. It is based on two premises: (i) the impact of climate change on biodiversity should be assessed on the basis of a large number of taxa and ecosystems and (ii) such evidence is urgently required, as conservation strategies and measures have to be adapted to climate change as soon as possible. The presented concept covers impacts on habitat types, species richness, diversity, distribution and abundance, and also phenological changes in habitat types and species. It contains a synthesis of the ecosystems, habitat types and groups of organisms for which detailed evidence on the nature of climate change impacts are crucially required. Existing biodiversity monitoring programmes should be continued and extended to assess climate change impacts, and complementary surveillance should be implemented for particular species groups (see table).

Data and study design are presented for Austrian monitoring programmes, such as the GLORIA high alpine climate impact monitoring programme, the ÖWI Austrian forest inventory, the Biodiversity-Nature-Safety (BINATS) programme, monitoring of cultural landscapes (ÖBM-Kulturlandschaft), monitoring for the water framework directive (WRRL-Monitoring), monitoring for the habitats directive (FFH-Monitoring) and several bird monitoring programmes implemented by BirdLife Austria (Vogelmonitoring). Methodological approaches for analysing climate change impacts, in particular a comparison of population trends for warm- and cold-adapted species, the change in thermophile indices for biological communities, and the change in altitudinal distribution patterns, are discussed and recommended for each of the monitoring programmes mentioned. Approaches that do and do not apply climate data are also evaluated and potentially useful climate data for Austria are presented.

In the framework of the evaluation of the ecosystems and species groups for which the impact of climate change on biodiversity needs to be monitored, we present priority ecosystem and species group combinations: in the nival and alpine zones, the monitoring of vascular plants following the GLORIA approach should be extended to other Austrian mountain regions; in forests the monitoring for vascular plants should be established, and along rivers and lakes amphibians and dragonflies should be monitored. In wet habitats (such as bogs, mires, floodplain forest and wet meadows) mosses, vascular plants, trees, amphibians, dragonflies and habitat types should be monitored, in dry habitats (such as dry meadows and sand dunes) vascular plants, reptiles, snails, grasshoppers, butterflies, bees and habitat types, respectively. Protected species that are not monitored so far should also be a priority target in all ecosystems.

We further present a general timeframe as well as a particular one for each monitoring programme. After a planning and tendering phase during the years 2018 and 2019, targeted data analyses for existing programmes as well as the initiation of additional programmes should take place from 2020 onwards in a five-year cycle. For the monitoring programmes GLORIA, ÖWI, BINATS, WRRL-Monitoring and the bird monitoring programmes, data from at least two surveys will already be available in 2020/21 and can be analysed for identification of climate change impacts on biodiversity. First analyses on climate change impacts on phenology using data from Phenowatch and other selected phenology monitoring programmes should also be carried out in 2020/21.

In the years 2025/2026, additional data from the existing monitoring programmes will be available. For ÖBM-Kulturlandschaft and the FFH-Monitoring, for instance, the data sets of the second surveys will be available and first analyses on climate change impacts could be undertaken subsequently (2026/2027). As climate change and its effects progress, further surveys every five years will be necessary to increase the precision of the impact assessments with longer and updated data series.

Species group (incl. Habitat types)	Nival	Alpine	Subalpine	Forests	Open land	Urban	Rivers	Lakes	Wet habitats[1]	Dry habitats[2]
Habitat types			☑		☑		☑	☑		
Fungi										
Soil organisms										
Mosses										
Phytoplankton							☑	☑		
Macrophytes							☑	☑		
Vascular plants	(☑)	☑	☑		☑					
Trees			☑	☑	☑					
Mammals										
Birds			☑	☑	☑	☑	☑	☑		
Reptiles										
Amphibians										
Fishes							☑	☑		
Snails										
Spiders										
Macrobenthos							☑	☑		
Dragonflies										
Grashoppers			☑		☑					
Butterflies			☑		☑					
True bugs										
Beetles										
Bees										
Ants										
Mosquitos						☑			☑	
Protected species	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑

[1] wet habitats such as bogs, mires, floodplain forests, wet meadows, etc.
[2] dry habitats such as dry meadows, sand dunes, etc.

Fig. 1: **Prioritisation of monitoring programmes for the assessment of climate change impacts on Austrian biodiversity. Presented are monitoring programmes for species groups (including habitat types) of nival, alpine, subalpine, forest, open land, urban, river, and lake ecosystems, and for wet and dry habitats. Coding: green background: priority monitoring programme; yellow background: monitoring useful, but not priority; orange background: monitoring programme not required; grey background: species group hardly exists in the ecosystem. ☑: existing monitoring programme.**

3 StartClim2016.B: Impact of climate change on the activity phases of animals using the example of amphibians in Austria and the use of plant phenology as an indicator

During the course of the year, amphibians migrate from water to terrestrial habitats and are dependent on water as spawning grounds. In order to protect endangered amphibians in Austria, amphibian fences are installed alongside highly frequented roads, and once or twice a day the animals are carried safely across the road in buckets by volunteers (method using drift fences and pitfall traps).

The development, rhythm of life and activity phases of the amphibians are highly influenced by external influences such as temperature, precipitation and photoperiod, which is why the beginning of migration and the period of fence monitoring vary according to location and year. Against the backdrop of a changing climate, changes in the development and activity phases (phenological events/phases) of amphibians can also be expected.

Currently, the time at which the fence is installed depends on weather conditions, first sightings or the first amphibians killed on the road. A **better and more effective way of delimiting the migration periods and of organising protection measures might be the use of plant phenological phenomena** such as the first blossoming of the spring snowflake. An early-warning system would help to utilise the time and manpower of the volunteers in a most rational way.

The AmphiKlim project investigated possible triggering factors for amphibian migrations, correlations between amphibian and plant phenology and possible changes in the time of spring migration, and identified **plant phenological phases** that could be used as an early-warning system.

Triggers for amphibian spring migration

According to specialist literature, amphibian activity and plant development phases are mainly influenced by temperature, water availability (precipitation) and photoperiod. Temperature is also mentioned in expert interviews as the strongest external trigger for starting migration, which, however, always has to be seen in connection with precipitation.

A **correlation** between the **start of migration** (here: day of the installation of the protection systems / start of monitoring) and **temperature** (average daytime temperature, average temperature at 0700) was also shown by statistical comparison of these factors. A correlation between temperature and migration was revealed, for example, in the analysis of the daily numbers of amphibians on a migration route, where in most of the investigated years the numbers of amphibians increased or decreased as a function of the temperature. Lack of precipitation can cause amphibians not to start migration in spite of suitable temperatures, which is why **precipitation in combination with temperature** is also defined as a migration-triggering factor. Conversely, there is no migration on days with heavy precipitation but too low temperatures (<3°C). As regards threshold values for migration-triggering factors, few concrete statements can be found in literature: mean daytime temperatures of 3–6°C are often defined as threshold values for the start of amphibian migration (cf. Kromp-Kolb et al., 2003; Münch, 1998). Quantitative data is also missing on precipitation conditions. According to the literature and expert interviews, the greatest migratory movements take place on mild spring nights with heavy precipitation. In the event of sustained drought and suitable temperature, however, amphibians start migration in spite of the absence of precipitation.

So far, an earlier migration start as a result of increasing temperatures caused by climate change has not been verified. In fact, the analysis shows great fluctuations in the migration start, which experts say are not unusual, as well as a tendency towards a later migration start or an increasingly more concentrated migration of the individual amphibian species (species migrating simultaneously). Experts assume that increasing drought in particular will produce "climate winners" (green toad) and "climate losers" (common frog, agile frog) among amphibians.

Amphibian protection measures and monitoring

The organisation and implementation of amphibian protection measures present great challenges (personnel resources, restricted financial funds, etc.) to the persons responsible (coordinators) and are dealt with in different ways. The organisation is sometimes handled by associations and includes, for example, coordination of the installation (perhaps by road maintenance staff) and monitoring of temporary systems (method using drift fences and pitfall traps), which is mainly done by volunteers (ideally several persons). Monitoring on the migration routes can therefore take various forms: more or less standardised data collection, data collection in central databases, analysis and reporting, or no storage or dissemination of data at all. The data quality also varies a lot (identification of species, genus, sex of the animals, counting of the individuals, or no recording at all).

Plants as early-warning system for amphibian migration

Taking into account a lead time of up to two weeks desired by the experts and route monitors, the first blossoming of hazel, spring snowflake and sallow were identified as indicators. The animals start to migrate about five days after the beginning of the first blossoming, with deviations dependent on the location and year. A reliable selection of plant phenological phases is only possible with an improved database and long-term monitoring on the migration route.

Conclusions

With the management systems currently in use, data management and scarce monitoring resources, plants do not appear to offer a reliable standardised indicator at present, especially as the monitoring of the migration routes and standardised collection of species, numbers of individuals and other relevant data appears to have higher priority. At a local level, plants are sometimes already (indirectly or unconsciously) perceived as indicators of the impending start of migration but are not used as a decision-making aid for the start of monitoring measures. Besides, according to experts, the scarce monitoring resources do not allow for an extension of monitoring periods (installation/inspection of the fence prior to the first migratory movements). An indicator system would therefore be conceivable only if a local plant phenological approach were sufficiently developed to deliver reliable indications about the start of the migration periods. In order to improve the potential of plants as an indicator of amphibian migration, route monitors will need to be made aware of the topic, and distinctive plant phenological phases during the period of amphibian migration will have to be recorded for several years. In this context, the installation of a monitoring network and the development of apps/actions within the framework of citizen science would be possible steps. Moreover, the link with other, local actions in the field of citizen science should also be checked. The present study suggests that an improved database would provide sufficiently reliable statements on the use of indicator plants to delimit migration times, making the additional effort of documentation worthwhile for the volunteers. As with ongoing climate change, the indicator plants could change – different species react at different rates to climate changes – and the documentation would have to be continued and adapted to possible indicator plants.

Given the situation of amphibians (all domestic species are endangered) and the climate scenarios for future years, survival of the amphibian population can only be ensured through a package of measures including habitat management, linking of habitats (landscape structures and permanent protection systems) and protection measures.

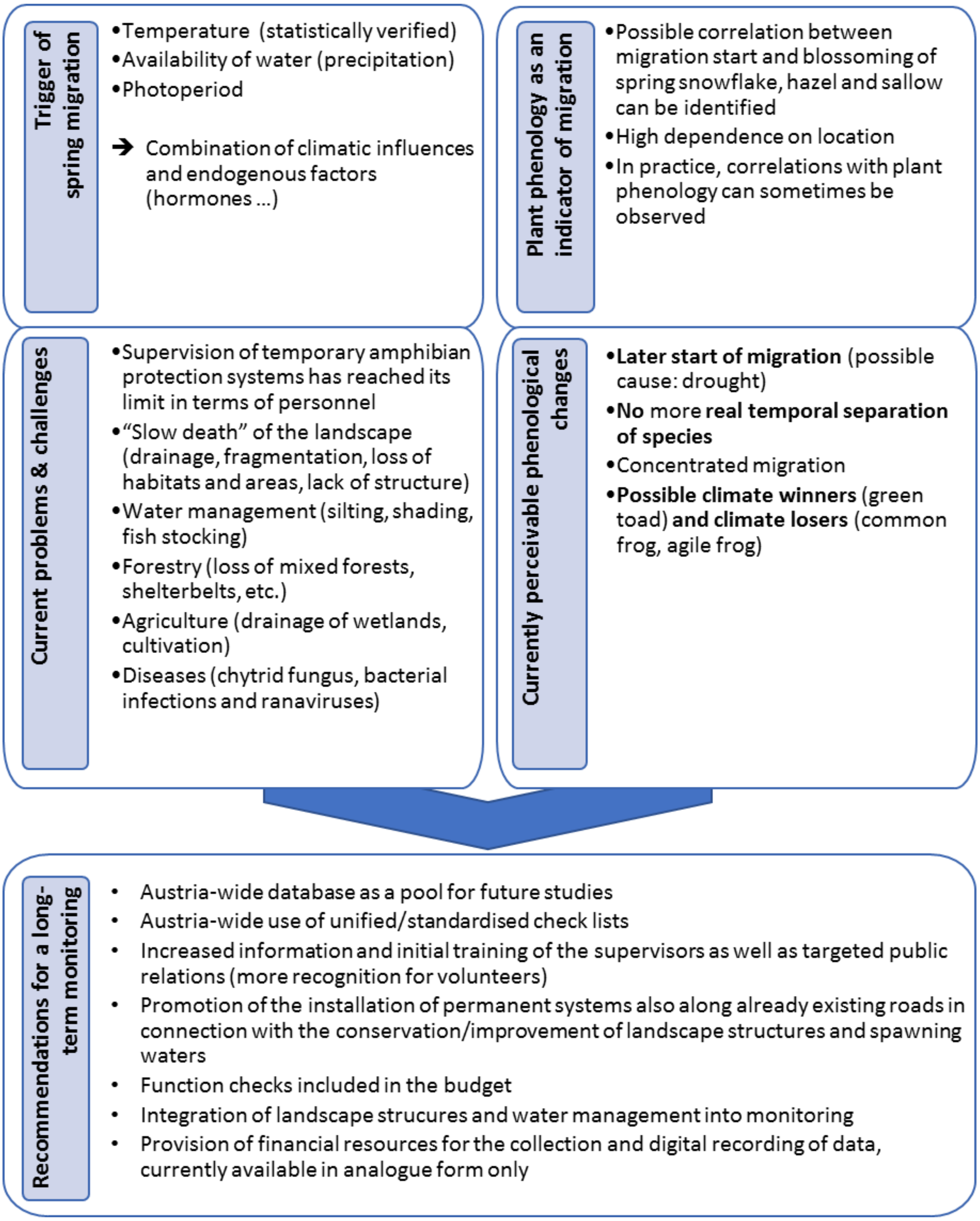

Fig. 2: Schematic illustration of the results of the research project

4 StartClim2016.C: BioRaw

Increasing utilization of biogenic raw materials is considered as a contribution to a sustainable economic system and as a measure towards climate protection. In this respect, the utilization of renewable raw materials is taken into account for energetic as well as for material uses. Waste materials (like slurry) may serve as a resource for further uses.

These new demands to primary production require the availability of (additional) acreage. Simultaneously, available acreage of cultural land decreases due to the build-up of settlements and infrastructures. Additionally, an impact of climate change to primary production is expected.

This literature study tries to integrate knowledge on primary production, demand on biogenous raw materials, available acreage, future yield and climate change from various projects in order to get an overall picture for the situation in Austria.

Demand on acreage, changes in cultural land

The base for discussion on demands on acreage and potentials of acreage is the fixed area of the Republic of Austria. The demands on acreage, caused by settlements, infrastructures and other forms of soil sealing as well as the abandonment of area for primary production decreases the available acreage for agricultural and forestry uses. While in 1970, about 660.000 ha were not assigned to an agricultural or forestry business, it was more than 1.000.000 ha in 2013. While forest land even increased, the decrease of grassland is most significant.

The interactions of future climate change, future production in agriculture and forestry and availability of areas to grow renewable raw materials for material as well as for energetic uses are investigated by several modelling studies with national scope within the forestry and agricultural sectors. This trend is ongoing, even accentuated.

The supply of biogenous raw material could be increased by reducing the agricultural overproduction, intensifying farming, increasing productivity, taking advantage of the substitute effects by producing fodder as a side-product in the biofuel production and by changing our diet.

The pressure on the available production areas and thereby upcoming competing claims to utilisation are basically dependent on the potential yields. Both are in turn influenced by the changing climate in the next decades.

Primary production and yields

The expected effects are varying with the assumed climate change scenarios. In general arable land will be more affected by climate change than grassland. Scenarios that are assuming severe climate change effects and increasing periods of droughts, especially in the eastern parts of Austria, come up with a considerable decline in yield. Dealing with biogenous raw materials on the basis of the “food-feed-fiber-tank logic”, which means the primacy of food over feed, fibre and energetic use, this scenario implies decreasing quantities or areas for material, chemical or energetic use. The energetic and material utilisation of wood biomass on forest land is possible to a certain extent, because 30% of the total harvested biomass can be used as energy wood.

The majority of modelling studies taking into account a moderate climate signal in respect to temperature increase predict increasing biomass production in Austria. While the production decreases within the arable land, production increases within the grassland.
Together with the increase of forestry related biomass production it causes the increase of total biomass production. Plausible production progress in agriculture through progress in technology, intensification, reduction of crop losses and irrigation may reduce these losses or

even overcompensate them. Thereby part of the available acreage could be used for bio energy production and material use of renewable raw materials (NAWAROS).

However, in some scenarios the presumed policy frameworks result in a strong extensification of agriculture. The mentioned production gain would be used up – among others - by an increased demand as a result of population growth. This would lead to a decrease of the level of self-sufficiency of arable crops. If increasing producer prices for bioenergy or biomass are achievable, for example due to subsidies, this would favour large-scale afforestations. This effect would be intensified by a cut down of payments for less favoured areas.

The type of land-use is strongly influenced by the level of achievable revenues, which also means that state subsidies are playing an important role in land management. An increase of agri-environmental subsidies may cause an extensification of farming which leads to a significant increase of ecological compensation conservation areas. In contrast a shortening of this financial support would result in an intensification of farming which would boost green-house gas emissions, loss of ecological compensation conservation areas, decrease of biodiversity and a change of semi-natural habitats. Furthermore the sectoral gross value added would increase at the expense of the producers' income.

Utilisation paths and qualities of raw materials

The Austrian governments´ strategy on science, technology and innovation (FTI-Strategy) concentrates on the bio based industry and demonstrates various possibilities of future development and use of resources along the supply chain. In this regard, it deals with the supply of resources (raw materials from agriculture, forestry and aquatic systems), the development of products (construction- and insulation materials, biogenous composites, biopolymers, bulk chemicals, biofuels, fertilisers, special bio based products) and manufacturing processes (fermentation, gasification, pyrolysis, wood processing, new bio refining concepts). The FTI-Strategy does not look into possible competition between different land uses and scarcities of acreage due to future climate change.

Availability, market and demand

Theoretically the demand of biomass for material- and energetic use could be met through imports. This would take the pressure from the Austrian production sites. Therefore the competition in the use of Austria's farm and grassland areas are to a high degree dependent on the situation at the European, respectively the international markets. Regarding the increasing material, chemical, and energetic utilization of biomass, an efficient use of scarce acreage is needed. Therefore it is particularly necessary to foster a multiple and cascadic use of biomass through integrated concepts (bio-refineries) and the use of residuals. The use of forestry related raw materials can be intensified because there is no direct completion with food production. "Externalised" social effects on land requirement like sealing and the loss caused by food waste have to be minimized. Technological advances, for example in the disciplines of breeding, biotechnology and genetic engineering, the sustainable optimization of the yield, the development of technologies, methods for the material and energetic use of bio-based raw materials, concepts of green bio-refineries and the restriction of losses in production and in reprocessing are further options. Following recommendations to change our eating habits to a balanced diet would cause a 30% reduction of the necessary area for agricultural production.

5 StartClim2016.D: Raising awareness as driver of social transformation in the context of climate change? How local and regional authorities raise awareness about climate change in the frame of e5 and KEM initiatives.

The question of social awareness is regarded as a key function in climate change discussions. It is hoped that it might trigger a rethinking process and herald the start of a social transformation. In Austria, several (inter)national programmes and initiatives exist in this area, most notably the Climate Alliance with almost 1,000 participating cities and municipalities, the 2000-Watt Society with two member cities in Vorarlberg, the Covenant of Mayors with sixteen municipalities and the Local Governments of Sustainability (ICLEI) network with two cities. Upper Austria has a programme for Upper Austrian Energy-Saving Municipalities (E-GEM).

The study compared the Austrian programmes Model Regions for Climate and Energy (KEM) of the Federal Government's Climate and Energy Fund and the Programme for Energy-Efficient Municipalities (e5). The two programmes are notable for their large coverage (almost 900 municipalities in ninety-nine KEMs, while the e5 programme is run in almost 200 municipalities in seven provinces) and their basically identical requirements and implementation profiles within the programmes and federal states. Above all, however, they are the main initiatives aimed at changing the decisions and behaviour of citizens and decision-makers in favour of climate protection. **The study focuses on the degree to which the programmes call for awareness-raising as a contribution to an attitude shift towards climate-friendly behaviour, especially among decision-makers at the municipal level, and the experience of the actors involved in the implementation process**.

A case study approach was chosen to investigate this question. Three regions operating as KEM and including at least one e5 municipality were selected for this purpose: Baden (Lower Austria), Weiz-Gleisdorf (Styria) and Vorderwald (Vorarlberg). In the course of the study interviews were conducted with nine decision-makers in the KEM regions and e5 municipalities, two programme managers from KEM and e5 at a higher level and a member of the advisory board of the Climate Alliance of Austria, who is at the same time climate protection officer of the province of Upper Austria. The interviews formed the core of the information collected and were supplemented by literature research and a workshop to discuss the interim results.

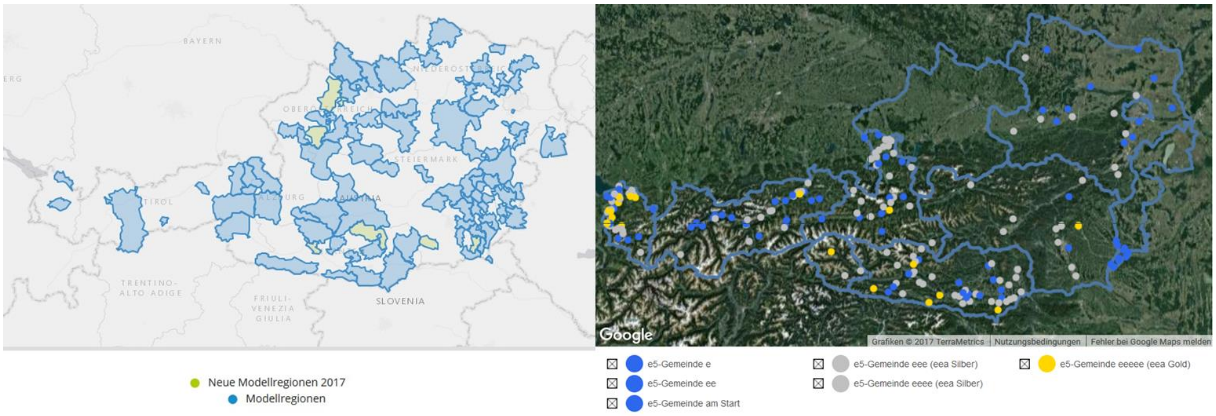

Fig. 3: Left: Model Regions for Climate and Energy, right: e5 municipalities

The twelve interviews may be regarded as the lower limit for a qualitative research methodology. This was taken into account when interpreting the results. Despite large differences between the regions and municipalities, however, broad agreement was found in the assessment of the interviewees, which encouraged us in the interpretation of the results.

Both programmes shared the goal of actively pursuing local climate policy and their understanding of awareness-raising as an integral part of this process. The starting point for the programmes and their implementation both differed considerably. The main divergences identified were their geographical focus (municipality vs. region), the specifications (catalogue of measures vs. free focus) and the financial resources (investment vs. access to funds). Furthermore, the measures were evaluated from the outset in the e5 programme, while this evaluation was not introduced in the KEM programme until 2015. In total, our interview partners perceived e5 as the more implementation-oriented approach.

The analysis of the three case study regions showed that far from conflicting with one another, the programmes complement each other well, provided that the actors are in regular communication. While this is already happening at the national level, at the regional level it depends on individuals. In that respect, it is also important to distinguish the levels of responsibility. The persons responsible are required to ensure that, although the municipality is part of a model region, it does not outsource its responsibilities to the region or the KEM manager.

The interviewees identified four categories of awareness-raising measures: public relations in local and regional media, the role model effect of municipalities (for example, thermal rehabilitation of municipal buildings), projects for raising awareness in schools and kindergartens, and projects that engage citizens (e-car sharing, etc.). It is interesting to note that they made little distinction between awareness-raising and other measures. The interview partners believed that successful implementation of climate-friendly projects was the best awareness-raising instrument and the most likely to find imitators.

Both programmes have led to the creation of a network to facilitate the exchange or dissemination of information among the participants on successful events, projects and approaches. A large number of elements in the field of awareness-raising, information and activities are also provided by the Climate Alliance, the programme with the most members among Austrian municipalities. This support is considered very helpful for local and regional stakeholders and is gladly accepted for raising awareness. In Upper Austria, municipalities receive financial support as well from the province's funding programme "Awareness-raising climate-relevant measures and activities in Upper Austria". The programme managers at federal or state level, in particular in e5, however, state that it is increasingly challenging to provide suitable instruments for all municipalities and their development stages.

A particular challenge is the long-term nature of awareness-raising activities and its implications, such as long-term motivation and the ongoing work considered necessary for social transformation in a region. Furthermore, it is difficult to find models or pioneers on the ground to present and report on climate-friendly alternatives. In addition, the implementation of the programme and consequently the awareness-raising activities are strongly dependent on political support. To that extent, the faintheartedness of political actors because of re-election fears was also perceived as a challenge. In that context, the programme managers expressed their desire to motivate mayors to participate in further training. Scarce resources are also an issue.

The most obvious effects in terms of awareness-raising could be found among those persons who – because of their active role in the programme – regularly dealt with the topics of energy saving and climate protection. This was especially true for programme working groups in the respective municipalities. For these people, the effect sometimes even went beyond pure awareness-raising and has already been reflected in concrete, changed modes of action. However, neither KEM nor e5 are isolated, but embedded in international, national, regional and local efforts to address climate protection. The two programmes contribute to this with their respective focus of activities.

6 StartClim2016.E: Detection of bark beetle infestation using an unmanned aerial vehicle (UAV)

As a result of climate change, many forest ecosystems experience increased stress caused by higher temperatures and/or less precipitation. At the same time, extreme events like storms and strong winds occur more often, leading to a rise in pest infestations. In Central Europe the bark beetle population (European spruce bark beetle and six-dentated bark beetle) in particular is likely to increase in coniferous forests. They pose a great ecological and economic risk because of their rapid spread and the enormous damage they cause. It is therefore important to develop rapid and simple methods to monitor forests for early signs of infestations.

The growing need for rapidly available, reliable and comprehensive forest data has resulted in an increasing use of remote sensing methods for forest monitoring. Up to now this data has been mainly based on satellite or airborne remote sensing sensors, which have been providing increasing information of constantly growing quality. In recent years, a trend towards the use of unmanned aerial vehicles (UAVs) for data retrieval has been observed. These systems are flexible to operate and provide data of very high spatial resolution. A disadvantage of UAVs is the limitation in the area that can be overflown. Thanks to their rapid operational readiness and flexible application, UAVs are suitable for identifying forest damage, be it the detection of wind throw or the identification of stressed, standing trees, as a result, for example, of bark beetle infestation.

This study focuses on the ability of a UAV to detect discoloured trees and the use of different camera systems to monitor vitality loss.

The discoloration of spruce trees weakened by six-dentated bark beetle starts in the tree crown. The information from pictures taken in the visible spectrum with a low-cost UAV is much more useful than time-consuming field inspections for detecting this change. The damaged trees are clearly visible from the air, and the position is easy to locate with appropriate methods. In the simplest mode, an overview of the forest area can be obtained with the UAV, starting from a suitable point and rotating the camera through a circular area of up to 50 ha. Two methods were tested for precisely locating a damaged tree. In one method the tree was overflown with the UAV and a picture taken with additional information, including the position of the image acquisition. In the other method, two pictures were taken from two different positions, using the two viewing angles to determine the location.

To compare the suitability of different camera systems for detecting loss of tree vitality, multiple cameras were mounted on one UAV to permit simultaneous image acquisition. Besides a commercial camera taking pictures in the visible spectrum (red-green-blue, RGB) two multispectral cameras were tested. Both measured additional reflectance in the near infrared, one with three and one with six channels. Additionally a thermal camera was installed. During the study period no additional bark beetle infestation could be observed, so the study focused on spruce trees already damaged. The distinctive discoloured treetops were clearly visible in the RGB images. The narrow-band, six-channel multispectral camera proved to be even more suitable. The damaged treetops were clearly visible when the data was displayed in a common false-colour image (Fig. 4). A similar result was obtained by calculating vegetation indices through the combination of different spectral channels. Here weakened treetops could be easily identified. In contrast to these results, the damaged treetops could not be identified with the three-channel multispectral camera because of the camera's broadband and overlapping channels. The data from the thermal camera was strongly influenced by solar radiation, leading to intense data noise.

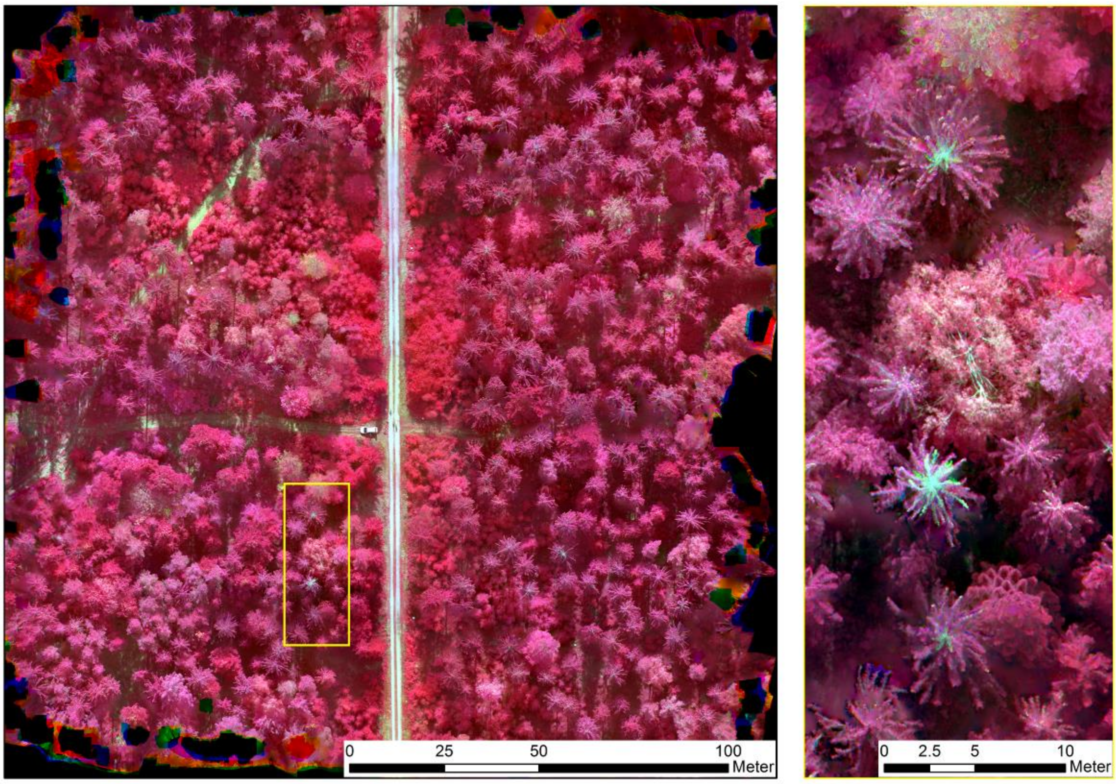

Fig. 4: False-colour image (CIR) of the study area (right) displayed with channels 6,4,2 of the six-channel multispectral camera, taken on 24 September 2016. In the detail image (left) three weakened spruce treetops are clearly visible (light treetops); note their different level of weakening.

When monitoring weakened trees it is important to consider the specific differences between tree species. The formation of cons in firs can lead to changes similar to the dying of needles. For single tree analysis it is thus advisable first to determine the tree species. A first analysis revealed that the six-channel multispectral camera was capable of registering the required spectral characteristics.

Another challenge when analysing the data obtained taken at different times of day and seasons was the varying illumination caused by the crown structure in combination with the changing solar zenith angle. These differences particularly affected the multi-temporal analysis of tree crowns.

To sum up, a well-planned UAV operation can provide considerable support for silvicultural practice. Simple and practical UAVs could be used for the localisation of certain points of interest, such as discoloured trees infested by bark beetle. Additional information can be obtained with the latest generation of multispectral cameras. This data can be used, for example, to differentiate tree species. Likewise, these cameras could probably detect changes in vitality at an early stage, ideally before they can be seen by the human eye. If these changes are observable, the future challenge will be to find the right time for the overflights. Thus, remote sensing sensors at various levels (from UAV to satellite) could be an important tool for the additional monitoring challenge in forests as a result of climate chance.

7 StartClim2016.F: Migration, climate change and social and economic inequalities

The relationship between climate change and migration has attracted increasing academic, public and political attention over the last few years. A huge body of research carried out on this topic has repeatedly pointed out that the relationship between climate change and migration is a multifaceted and complex phenomenon. This short-term project summarises the state of research on potential migration scenarios discussed in academic literature, analyses its relevance for Europe and Austria and reviews available statistical data in this context. A further main focus was consideration of the relevant social and economic inequalities.

As climate change interacts with social, economic, political and other factors, causal relationships between climate change and migration are hard to establish, and possible future developments and forecasts are difficult to project. In its 2014 report, the Intergovernmental Panel on Climate Change confirmed that there are no reliable forecasts of changes in migration because of its complex, multi-causal nature. The discussion is complicated by the fact that the movement of people in the context of environmental threats is not a new phenomenon; on the contrary, weather-related events and natural disasters have caused displacement and triggered movement of people in the past.

A broad range of migration responses and strategies are associated with environmental and climate change. There are specific **migration scenarios** that are discussed in the context of climate change. These scenarios are to a large extent associated with the specific “cause” of migration, such as the nature of disasters.

a) The most obvious category is migration in connection with **sudden-onset disasters**, also subsumed under extreme weather events, including tropical cyclones, heavy rains and floods. The effect of sudden-onset disasters on migration is widely acknowledged and discussed as one of the most obvious and explicit scenarios in the context of climate change. Each year at least twice as many people, and often greater multiples, are displaced by natural disasters than by conflict or wars. According to the Internal Displacement Monitoring Centre (IDMC), in 2016, 23.5 million people were displaced – at least temporarily – after a natural disaster, 97 per cent of which were caused by climate- or weather-related events. Asia is the continent most affected by natural disasters. In 2016, 85 per cent of people displaced by disasters lived in South Asia, East Asia and the Pacific. In Europe and Central Asia 0.1 million people (that is only 0.2 per cent of the total population) were displaced by disasters in 2010 according to the IDMC. In most cases, disasters led to short-term, internal migration. However, the IDMC also highlighted examples from Japan, Bangladesh, Pakistan, USA, Indonesia and other countries, where natural disasters can also lead to protracted displacement. Migration as a consequence of natural disasters may also lead to forms of circular movements. However, sudden-onset disasters do not automatically cause migration. People may be either unwilling or unable to move. In addition, they may even move towards zones of heightened environmental risks.

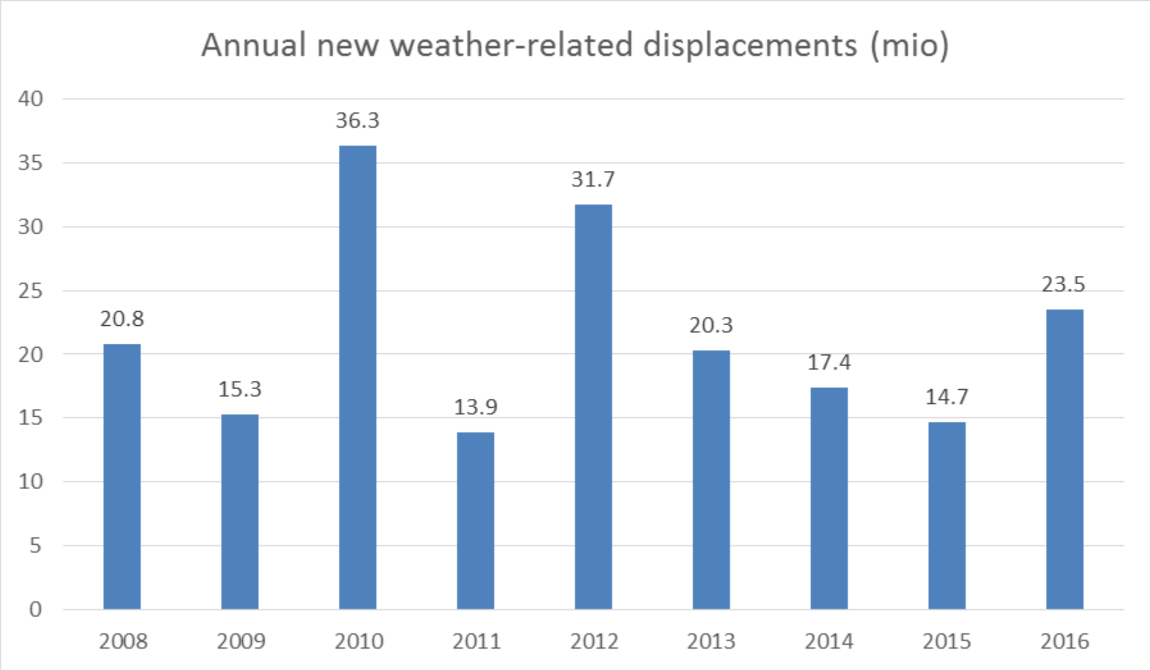

Fig. 5: Between 2008 and 2016, an average of 21.5 million people were displaced due to weather-related disasters per year. That is about 60,000 persons/day (based on IDMC data).

- **Long-term environmental change** or **slow-onset environmental degradation** caused, for example, by droughts and desertification, rising sea levels, increased salinization of groundwater: This category is often considered to be an increasingly important factor in the context of migration. Migration patterns in connection with slow-onset events are diverse and context-specific; the interaction between different and diverse factors is still not well understood, and the migration outcomes are difficult to project. The influence of climate change on the decision to migrate is often indirect and closely related to social and economic aspects, such as income, type of income, unemployment, access to education, potentially available migration networks and social relationships, poverty, and inequality with regard to gender, ethnicity or age. This scenario is very often associated with diverse forms of labour migration – internal or external, short-term, circular or permanent. Labour migration in the context of climate change is frequently seen as a strategy to diversify income and is thus also understood as an adaptation strategy; in other words, it is a strategy to adapt to changing climate. The concept of **migration as adaptation** is linked with this scenario.
- **Displacement caused by conflict** and disturbance of public order, violence or armed conflict associated with a degrading environment or related to conflict on decreasing resources: Again, environmental degradation does not automatically lead to conflict and, subsequently, to displacement. Political, economic and social aspects such as historical conflicts, mismanagement or diverse forms of inequality seem to play a more decisive role in this context.
- **Trapped-population**: These are people who cannot move although the environment is deteriorating and becoming a serious threat because they do not have the means to do so. Migration requires financial and social resources, and people who do not have the means to move will be trapped in increasingly dangerous environments. Especially poor people and groups, very often women, children, elderly people and other disadvantaged groups, will increasingly be forced to remain in dangerous areas.

In conclusion, migration patterns in the context of climate change are multifaceted, diverse, complex and context-related and they are closely related to different forms of inequality. Climate change will have considerably negative effects on poor regions and people who have contributed only little to the changing of the climate. Compared to other regions, Europe (including Austria) will be little effected by devastating natural disasters. Because of its wealth it will also be better able to adapt to a changing climate. Migration within Europe in the context of climate change will therefore play only a minor role.

Migration due to climate change is likely to be primarily internal. Movement towards Europe as a result of climate change is not very well researched. There are many openings for political measures, including adaptation measures in the context of climate change and migration. They include the acknowledgement and enabling of migration as an adaptation strategy, the protection of the human rights of migrants, guaranteeing the rights of people who are internally or internationally displaced by natural disasters, protecting the rights of persons affected by climate-response measures or support of people, countries and regions that are particularly affected by climate change.

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9 List of figures

Annex
The following projects were part of StartClim2010 to StartClim2015. All StartClim reports can be found on the StartClim2016 CD-ROM or downloaded from the StartClim webpage (www.startclim.at).

Contributions to StartClim2010

StartClim2010.A: Fields of action and responsible actors for climate change adaptation of public parks in cities
Institute of Landscape Development, Recreation and Conservation Planning (ILEN), BOKU: Stephanie Drlik, Andreas Muhar

StartClim2010.B: Recommendations for an adaptation of urban open and green spaces in Austrian cities and city regions
PlanSinn GmbH, Office for Planning and Communication: Erik Meinharter
Federal Environment Agency: Maria Balas

StartClim2010.C: The social costs of adaptation: approaches to an evaluation of adaptation options (SALDO)
Wegener Center for Climate and Global Change, University Graz: Birgit Bednar-Friedl, Olivia Koland, Janine Raab
Federal Environment Agency: Martin König

StartClim2010.D: Integrated precautionary and adaptation measures for the Marchfeld region
Institute for Sustainable Economic Development, BOKU: Christine Heumesser, Mathias Kirchner, Erwin Schmid, Franziska Strauss

StartClim2010.E: Ecological and silvicultural characteristics of European larch (Larix decidua Mill.) – consequences for forest management in Austria in consideration of climate change
Institute of Silviculture, BOKU: Eduard Hochbichler, Gabriele Wolfslehner, Roland Koeck, F. Arbeiter
Federal Research and Training Centre for Forests, Natural Hazards and Landscape: Herfried Steiner, Georg Frank
Institute of Meteorology, BOKU: Herbert Formayer

Startclim2010.F: Hot town, summer in the city – effects of hot days on recreational and leisure behaviour and sightseeing programmes of city tourists as exemplified by the case of Vienna
Institute of Landscape Development, Recreation and Conservation Planning (ILEN), BOKU: Christiane Brandenburg, Brigitte Allex, Ursula Liebl, Christina Czachs
Institute of Meteorology, BOKU: Thomas Gerersdorfer

StartClim2010.G: Knowledge-based platform to optimise operations strategies in handling natural hazards
Austrian Red Cross: Jürgen Högl, Clemens Liehr, Gerry Foitik
Institute of Production and Logistics, BOKU: Manfred Gronalt, Magdalena Schweiger, Patrick Hirsch

Contributions to StartClim2011

StartCim2011.A: Climatic influence on voltinism and spread of the spruce bark beetle, Ips typographus, in alpine areas
Institute of Forest Entomology, Forest Pathology & Forest Protection, BOKU: Axel Schopf, Emma Blackwell, Veronika Wimmer

StartClim2011.B: Analyzing Austria's forest disturbance regime as basis for the development of climate change adaptation strategies
Institute of Silviculture, BOKU: Rupert Seidl, Dominik Thom
Institute of Forest Protection, Federal Research and Training Center for Forests, Natural Hazards, and Landscape (BFW): Hannes Krehan, Gottfried Steyrer

StartClim2011.C: Effects of soil drying on the transpiration of Austrian tree species
University of Innsbruck: Georg Wohlfahrt, Stefan Mayr, Christoph Irschick, Sabrina Obwegeser, Petra Schattanek, Teresa Weber, Dorian Hammerl, Regina Penz

StartClim2011.D: Adapting Austrian forestry to climate change: Assessing the drought tolerance of Austria's autochthonous tree species
Institute of Botany, BOKU: Gerhard Karrer, Gabriele Bassler
Institute of Forest Ecology, BOKU: Helmut Schume, Bradley Matthews
Vienna Institute for Nature Conservation and Analyis, V.I.N.C.A: Wolfgang Willner

Contributions to StartClim2012

StartClim2012.A: Cover crops as a source or sink of soil greenhouse gas emissions?
Division of Agronomy, Department of Crop Sciences, BOKU: Gernot Bodner, Andreas Klik, Sophie Zechmeister-Boltenstern

StartClim2012.B: Effects of climate change on soil functions: metadata analysis
Federal Research and Training Centre for Forests, Natural Hazards, and Landscape (BFW): Michael Englisch, Barbara Kitzler, Kerstin Michel, Michael Tatzber
Federal Agency for Water Management, Institute for Land & Water Management Research (BAW-IKT): Thomas Bauer, Peter Strauss
Austrian Agency for Health and Food Safety (AGES): Andreas Baumgarten, Hans-Peter Haslmayr
Federal Environment Agency: Alexandra Freudenschuß

StartClim2012.C: Disturbance of forest stands and humus loss
Institute of Forest Ecology, BOKU: Douglas Godbold, Mathias Mayer, Boris Rewald

StartClim2012.D: To count with and on wood: adaptations of tools and data (German: Holz BZR)
Kompetenzzentrum Holz GmbH: Tobias Stern, Franziska Hesser, Georg Winner, Sebastian Koch
Institute of Marketing and Innovation, BOKU: Leyla Jazayeri-Thomas, Verena Aspalter, Martin Braun, Wolfgang Huber, Peter Schwarzbauer
Institute of Wood Science and Technology, BOKU: Robert Stingl, Marie Louise Zukal, Alfred Teischinger
Federal Environment Agency: Peter Weiss, Alexandra Freudenschuß

StartClim2012.E: Snow line climatology within the Alpine region, derived from re-analysis data
Institute of Meteorology, BOKU: Herbert Formayer, Imran Nadeem

StartClim2012.F: Values as performance indicators: a path towards a proactive climate protection
Centre for Global Change and Sustainability, BOKU: Maria Miguel Ribeiro, Julia Buchebner

Contributions to StartClim2013

StartClim2013.A: Thermal stress for brown trout in the headwaters of the river Traun during summer
Harald Ficker, M.Sc.

StartClim2013.B: Loss of floodplains and flood risk in the context of climate change
Institute of Water Management, Hydrology and Hydraulic Engineering, BOKU: Helmut Habersack, Bernhard Schober, Daniel Haspel

StartClim2013.C: Runoff scenarios in the Ötztal valley (Tyrol, Austria) considering changes to the cryosphere as a result of climate change
alpS GmbH: Matthias Huttenlau, Katrin Schneider, Kay Helfricht, Klaus Schneeberger
Institute of Meteorology, BOKU: Herbert Formayer

StartClim2013.D: Recommendations for changes to regional development and spatial planning in areas of high flood risk
PlanSinn GmbH - Office for Planning & Communication: Bettina Dreiseitl-Wanschura, Erik Meinharter, Annemarie Sulzberger
Rambøll Group: Herbert Dreiseitl
Federal Environment Agency GmbH: Theresa Stickler, Jochen Bürgel

StartClim2013.E: How and where will Austrian river systems respond to climate change? An interdisciplinary analysis of fish fauna and nutrients
Institute of Hydrobiology and Aquatic Ecosystem Management, BOKU: Thomas Hein, Andreas Melcher, Florian Pletterbauer
Department of Integrative Zoology, University of Vienna: Irene Zweimüller

StartClim2013.F: GIAClim – Gender Impact Assessment in the context of climate change adaptation and natural hazards
Institute of Landscape Planning, BOKU: Doris Damyanovic, Florian Reinwald, Britta Fuchs, Eva Maria Pircher
Institute of Landscape Development, Recreation and Conservation Planning, BOKU: Christiane Brandenburg, Brigitte Allex
Institute of Mountain Risk Engineering, BOKU: Johannes Hübl, Julia Eisl

StartClim2013.G: Validation of the applicability of the SIMAGRIO-W wireworm prognosis model, based on soil temperature and moisture measurements, in Eastern Austrian agriculture
Bio Forschung Austria: Patrick Hann, Katharina Wechselberger, Rudi Schmid, Claus Trska, Birgit Putz, Markus Diethart, Bernhard Kromp
Zentralstelle der Länder für EDV-gestützte Entscheidungshilfen und Programme im Pflanzenschutz (ZEPP): Jeanette Jung
Institute of Meteorology, BOKU: Josef Eitzinger

Contributions to StartClim2014

StartClim2014.A SNORRE - Screening of remarkable weather
Zentralanstalt für Meteorologie und Geodynamik (ZAMG): Christoph Matulla, Brigitta Hollosi
Federal Environment Agency: Maria Balas

StartClim2014.B: Developing a method for assessing climate change effects on productivity and animal welfare as well as adaptation potential of livestock husbandry
Institute of Livestock Sciences, BOKU: Stefan Hörtenhuber, Werner Zollitsch

StartClim2014.C: Effects of ambient temperature on performance and health traits in dairy cattle when considering husbandry factors
Institute of Livestock Sciences, BOKU: Birgit Fürst-Waltl, Verena Auer
ZuchtData EDV-Dienstleistungen GmbH: Christa Egger-Danner, Franz Steininger
Institute of Meteorology, BOKU: Herbert Formayer, David Leidinger
Höhere Bundeslehr- und Forschungsanstalt für Landwirtschaft Raumberg-Gumpenstein: Elfriede Ofner-Schröck, Eduard Zentner
LKV Austria: Karl Zottl

StartClim2014.D: On the importance of climate change for nutrition and diseases of alpine game
Gesellschaft für Wildtier und Lebensraum (GWL): Armin Deutz, Gunther Greßmann
Höhere Bundeslehr- und Forschungsanstalt für Landwirtschaft Raumberg-Gumpenstein: Thomas Guggenberger, Albin Blaschka

StartClim2014.E: Weather-independent tourism offers based on Nature experience offers - relevance and innovative development options
Institute of Landscape Development, Recreation and Conservation Planning, BOKU: Ulrike Pröbstl-Haider, Verena Melzer

StartClim2014.F: permAT – Long-term monitoring of permafrost and periglacial processes and its role for natural hazard prevention: Possible strategies for Austria
Department of Geography and Regional Science, University of Graz: Andreas Kellerer-Pirklbauer, Christoph Gitschthaler, Michael Avian
Zentralanstalt für Meteorologie und Geodynamik (ZAMG): Annett Bartsch, Stefan Reisenhofer, Gernot Weyss, Claudia Riedl

Contributions to StartClim2015

StartClim2015.A: Re-inventing prevention? - An analysis and evaluation of approaches and tools for flood and heavy precipitation self-provision and private prevention (RE-Invent)
Institut für Interdisziplinäre Gebirgsforschung IGF, Österreichische Akademie der Wissenschaften: Axel Borsdorf, Stefanie Rohland
Wegener Center für Klima und Globalen Wandel, Universität Graz: Philipp Babcicky, Sebastian Seebauer
Landesfeuerwehrverband Vorarlberg: Clemens Pfurtscheller

StartClim2015.B: RELOCATE – Relocation of flood-prone households in the Eferding basin: Accompanying research on social impacts

Wegener Center für Klima und Globalen Wandel, Universität Graz: Philipp Babcicky, Sebastian Seebauer

StartClim2015.C: Monitoring the effects of climate change on the Austrian bird fauna
BirdLife Österreich: Erwin Nemeth, Norbert Teufelbauer
Zentralanstalt für Meteorologie und Geodynamik (ZAMG): Ingeborg Auer, Brigitta Hollòsi

StartClim2015.D: Maintaining the protective services in Austrian forests under conditions of climate change
Institut für Waldbau, BOKU: Manfred Lexer, Florian Irauschek, Werner Rammer

StartClim2015.E: Risk assessments for selected protection forest types of the Eastern Alps (Austria and Southern Tyrol) with reference to the disturbance regimes storm/snow damage/drought - bark beetle– forest fire and climate change
Institut für Forstentomologie, Forstpathologie und Forstschutz, BOKU: Axel Schopf, Peter Baier, Sigrid Netherer, Josef Pennerstorfer