

Spatial and Settlement Development Adapted to Climate Change in Strasshof an der Nordbahn (Lower Austria)

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1 ABSTRACT

Climate change, increasing urbanisation and densification, not only in inner-city areas, require new approaches and solutions to improve liveability and act against the consequences of climate change, primarily noticeable in cities and their surrounding areas. The introduced projects "Strasshof 2021" and "Strasshof. Klimafit!" (both funded by the Austrian Climate and Energy Fund, Klima- und Energiefonds, under the Smart Cities Initiative in Austria) deal with climate change adaptation measures, exemplified by the Austrian municipality of Strasshof an der Nordbahn, using instruments of spatial planning, such as land development plans, construction plans, zoning plans etc., focussing on soil bioengineering measures to infiltrate rainwater as well as climate-effective design of roadside greenery using a selection of plants appropriate to the climate.

Within the exploratory project "Strasshof 2021. Preparation of climate change-adapted planning instruments and processes for a Smart Village" the municipality of Strasshof examined in cooperation with the project team, how certain climate change adaptation measures could be specifically requested and regulated in the municipality's development plan, including how compliance and implementation of these measures could then be monitored by the municipality. At the level of the land development plan, criteria were developed suitable for implementing climate change-adapted settlement developments. Existing experiences were transferred to Strasshof and measures and options for climate change-adapted rainwater management were developed. For example, potential implementations of the sponge city principle, adapted to the local conditions (no canal for draining rainwater, very permeable soil) were examined in Strasshof. Based on the assessment of potential areas to establish green structures and roadside greenery in Strasshof, measures and options for climate change adapted planting and vegetation in public spaces and on buildings were analysed. A list of "climate-fit" trees (trees that are well-adapted to the changing climate) for public areas as well as for private gardens was drawn up.

"Strasshof. Klimafit! Strasshof as a lighthouse: EVAPO+ green walls, green infiltration troughs, empowerment and practical transfer" is a lighthouse demonstration project that stimulates processes for climate change measures by empowering other municipalities and small towns. The project aims to implement resilient, multifunctional and "climate-fit" solutions that respond to heat and heavy rain, improve the microclimate, increase the quality of life and living while promoting biodiversity and species diversity in existing areas of the municipality. With these measures, Strasshof can act against climate change consequences and improve the liveability of the population. The transferability of the demonstrations shall be guaranteed with the help of various regional, national and international exchange forums. In cooperation with other Austrian municipalities, the lessons learned from Strasshof will be reflected and transferred to the regional network "Climate-Fit Small Towns and Municipalities" along with step-by-step instructions for climate-fit municipalities.

Keywords: strategy, climate adaptation, regulation plan, urban heat island, Lower Austria

2 BASELINE

It is undisputed that climate change has an impact on our daily lives and should be taken into account when planning our living environment and therefore also for matters of spatial planning. Climate change, increasing urbanisation and densification, not only in inner-city areas, require new approaches and solutions to improve liveability and to act against the consequences of climate change, primarily noticeable in cities and their surrounding areas. Urban space, which is also found in the outskirts of large cities, causes an increase in temperature per se which is then, intensified by the change in climate. Due to the high percentage of sealed surfaces evaporation is reduced while the solar irradiation on building and road surfaces is stored at the same time. The consequences of climate change, made especially clear by extreme weather events (heat, drought, heavy rain events), are primarily noticeable in cities and their outskirts. Numerous studies have already proven that through evapotranspiration plants can make an essential contribution to the fight against climate change and, at the same time, improve wellbeing and livability. In many places, however, green areas lose ground due to the creation of housing. More and more people choose to live outside of large cities which burdens the surrounding communities with severe influx. That said, the majority of climate change adaptation is solely concerned with combatting the overheating of large cities. However, surrounding areas, small towns and rural communities are also affected by climate change, hence the need to take measures for climate change adapted spatial planning there too, in order to increase quality of life and improve the microclimate. (Fechner et al. 2020; Krauss et al. 2019)

This paper focusses on actions and measures for climate-change adaptations in smaller cities and villages, demonstrated by the example of the municipality Strasshof an der Nordbahn in Lower Austria. To implement and demonstrate climate-change adaptations in Strasshof an der Nordbahn, two projects designed by the same project consortium were funded: the one-year exploratory project "Strasshof 2021. Preparation of climate change-adapted planning instruments and processes for a Smart Village" (September 2020 to September 2021) laid the foundation for the current three-year Smart Cities follow-up project (experimental development) "Strasshof. Klimafit! Strasshof as a lighthouse: EVAPO+ green walls, green infiltration troughs, empowerment and practical transfer" (April 2022 to March 2025) (both funded by the Austrian Climate and Energy Fund, Klima- und Energiefonds, under the Smart Cities Initiative in Austria). The following paper will present the main results from the completed exploratory project and present an outlook on the planned actions and measures within the follow-up project for experimental development and implementation.

3 EXPLORATORY PROJECT "STRASSHOF 2021. PREPARATION OF CLIMATE CHANGE-ADAPTED PLANNING INSTRUMENTS AND PROCESSES FOR A SMART VILLAGE"

The project "Strasshof 2021" was an exemplary study addressing the above-mentioned issues and interests, carried out in Strasshof an der Nordbahn in Lower Austria. With the help of construction bans, Strasshof has already been taking on municipal tasks that have become pressing in recent years due to enormous population growth. Equally urgent still is the development of climate change-adapted strategies, through which the community can prepare for changing climatic conditions. Through intensive research, possible actions for a local land development plan adapted to climate change issues, as well as possibilities for sustainable rainwater management and roadside greenery were explored: The exploratory study researched ways to integrate climate change adapted measures into spatial planning by especially dealing with the adaptation of the local development plan, analysed vegetation-related soil bioengineering measures to optimize the local rainwater infiltration and addressed the climate-effective design of roadside greenery through a climate change-adapted selection of plants. The research findings led to an assessment of potential measures specifically designed for the community of Strasshof as experimental space. The design of the project was matched to the procedures within the community. An accompanying participative process led to the population becoming sensitised to actions able to be taken and created a knowledge base for understanding and implementing climate-adapted measures in the community. The project exemplifies ways of optimising microclimate effective measures and spheres of activity for communities.

3.1 Creating the baseline: Potential analysis for climate change adapted planning in Strasshof

Already in the initial phase of the project, the project team, consisting of companies from spatial and landscape planning, vegetation technology (the authors of the paper) and the municipality itself (mayor and

head of the building authority), identified specific problem areas and potential fields of action in which measures could and should be taken in order to design a climate-friendly community.

3.1.1 Analysis of the development plans' potential towards climate change measures

Amongst other objectives, one focus of the analysis, in particular, was to examine how certain climate-change adaptation measures could be specifically requested and regulated in the municipality's land development plan, including the question of how compliance and implementation of these measures could then be monitored by the municipality. Basically, the land development plan is an important instrument for defining the settlement area at the municipal level. Based on the zoning plan, the land development plan contains regulations for the land use – specifically plots of land – with regard to the spatial arrangement and building architecture (including community, semi-detached and detached housing, open development, development height, building lines, building forms, technologies), as well as regulations for transport development. For Lower Austrian municipalities, the following legal bases are relevant: the Lower Austrian Spatial Planning Act [NÖ Raumordnungsgesetz], the Lower Austrian Building Code [NÖ Bauordnung] and the Lower Austrian Building Technology Ordinance [NÖ Bautechnikverordnung]. A positive external driver in this context is the amendment to the Lower Austrian Spatial Planning Act 2014, which was passed on October 22, 2020, according to which, among other things, additional specifications in the land development plan are possible in order to ensure climate- and noise-adapted building. In this way, maximum dimensions of building sites, as well as requirements for green roofs or facades, and the creation of rainwater cisterns or infiltration areas, can be regulated.

3.1.2 Foreseen Measures and Actions

According to identified problem areas and potential fields of action, the following areas of attention and thematic priorities were identified and dealt with – each specifically related to the municipal area of Strasshof:

- (1) Development of proposals for a climate change-related adjustment of the local land development plan
- (2) Development of proposals for the climate-efficient use of rainwater
- (3) Exploring possible locations for green structures and roadside greenery to reduce urban heat and to absorb rainwater in the natural soil
- (4) Exploring the possibilities of climate change-adapted planting up to a climate-effective design with plants in combination with buildings, settlement structures, rainwater management, vegetation technology and biological engineering measures
- (5) Strengthening the awareness of the population towards climate change adapted spatial measures

As part of the exploratory project, the potentials and possibilities occurring through the spatial planning legislation were examined, especially regarding possible implementations and achievable results. On the other hand, specific potential measures for climate change adaptation such as infiltration areas, rainwater management and climate-friendly planting were defined and examined as to how they could be integrated into the legal framework and into practice in the municipality.

3.1.3 Results of the exploratory project

The results of the exploratory project outline the specific potentials for climate change adaptation regarding spatial planning for the municipality of Strasshof, sorted by measures and thematic areas.

After detailed spatial, vegetation-related and social analyses of areas potentially relevant for climate change adaptation measures in the municipality, areas and precise locations for potential implementations were defined in collaboration with the municipality. Solutions were proposed by the specialist planning project team.

Definition of locations and areas for future implementation

- Climate change adaptation measures in street spaces: Proposals for a vegetation-engineered plant-related design of infiltration areas for selected locations with different street widths and zoning, main and secondary streets in selected housing estates were developed.

- Climate change adaptation measures on private property and private plots of land with residential buildings: Climate change adaptation measures were created that can be implemented by private individuals in single-family homes with gardens, in particular the promotion of rainwater infiltration, also rainwater harvesting and planting with climate-smart plants.
- Climate change adaptation measures for municipal buildings focussing (vertical) greening: In the new location of the municipal office as well as for more municipal buildings like the education campus in Strasshof different forms of façade greening were exploited. Impetus for the implementation of building greenery and rainwater management through contributions to building competitions was provided.

Recommendations for climate change-adapted spatial planning

At the level of the land development plan, criteria were developed that are suitable for the implementation of climate change adapted settlement developments. Existing experiences were transferred to Strasshof and measures and options for climate change-adapted rainwater management were developed.

- Potential implementations of the sponge city principle, adapted to the local conditions (no canal for draining rainwater, very permeable soil) were examined in Strasshof.
- Based on the assessment of potential areas for the establishment of green structures and roadside greenery in Strasshof, measures and options for climate change adapted planting and vegetation in public space and on buildings were analysed.
- A list of "climate-fit" trees (trees that are well-adapted to the changing climate) for public areas as well as for private gardens was drawn up.



Figure 1: Project folder "What can I do?" (Source: RaumRegionMensch ZT GmbH)

Information campaign

An important aspect of climate change-adapted planning measures is certainly informing the local population, not least about the possible contribution of spatial planning to the topic. The implementation of

climate change-adapted planning instruments and processes requires sensitisation and the involvement of the population. For the exploratory study in Strasshof, the population was involved – taking into account the possibilities under COVID-19 conditions – and the project results were prepared and presented for specific target groups. Thanks to the cooperation with the adult education center in Strasshof, a four-part series of lectures showed how residents can shape their own properties to adapt to climate change. The project and the results were presented as part of an exhibition displaying the changed development plan on September 22, 2021. Feedback from the population was obtained using interactive formats. Information about the project was regularly published in the municipal newspaper.

The detailed results from the exploration study can be accessed at <https://smarcities.at/projects/strasshof-2021/>

3.1.4 Impact and achievements

In summary, the "Strasshof 2021" exploratory project has led to the following impact and achievements:

- Using the example of one municipality, it was possible to develop solutions for climate change-adapted spatial planning.
- Research results and recommendations for climate change adaptation measures in spatial planning (development planning, rainwater management, sponge city principle, "climate-fit" trees) were linked to specific locations and case studies in Strasshof an der Nordbahn.
- Strasshof an der Nordbahn received specific support on its way to becoming a model municipality in terms of climate change adaptation in spatial planning.
- The amendment to the Lower Austrian Spatial Planning Act in October 2020 has so far been rather hesitantly perceived by the Lower Austrian municipalities. Strasshof is an exception and, with the support of the project team, was one of the first municipalities to actively deal with the extended paragraph 30 (content of the land development plan), which enables an implementation of measures towards climate change-adaptation in the land development plan.
- The project as well as the results were disseminated within the population via articles in the municipalities newspaper, a series of lectures at the adult education center in Strasshof, a project folder addressing individuals and their actions, and an information event. Raising awareness for spatial measures towards climate change adaptation and the examples presented for a "climate-fit" Strasshof, from which all the residents would ultimately profit, contributed directly to the local added value in Strasshof.
- The series of lectures in the adult education center of Strasshof was mostly attended by the same people and contributed to a "community" forming around the topic "our climate-fit Strasshof". The spontaneous excursion to a private garden after the fourth lecture especially contributed to the interaction and networking of interested participants.
- Knowledge transfer and networking within the project team and with relevant stakeholders in spatial planning in Lower Austria took place and contributed to local added value in other municipalities.
- The baseline was established, for the municipality of Strasshof, to improve quality of life for the population using the proposed measures and to prepare optimally for climate change. This would serve as an example for other municipalities as well and might lead to imitation.

4 FOLLOW-UP PROJECT (EXPERIMENTAL DEVELOPMENT) "STRASSHOF. KLIMAFIT! STRASSHOF AS A LIGHTHOUSE: EVAPO+ GREEN WALLS, GREEN INFILTRATION TROUGHS, EMPOWERMENT AND PRACTICAL TRANSFER"

The exploration project "Strasshof 2021" specifically highlighted the possibilities and needs of the municipality of Strasshof an der Nordbahn with regard to climate change adaptation and showed, among other things, that with the local conditions, dealing with rainwater both in public space and on private property is essential. Measures need to be taken to deal with increasingly hot days in order to counteract dry phases and improve the microclimate. It therefore requires, among other things, combined nature-based solutions on the one hand for cooling and, on the other hand, for handling rainwater. As a result, the follow-up demo project "Strasshof. Klimafit!" has been funded for 3 years (April 2022 to March 2025), which

allows the implementation and manifestation of the findings and results of the exploratory study towards climate change adaptation in both public and social spaces and in spatial planning processes at Strasshof. The project continuously deals with climate change adaptation measures, exemplary for the Austrian municipality of Strasshof, within instruments of spatial planning, such as land development plans, construction plans, zoning plans etc., focussing on soil bioengineering measures to infiltrate rainwater as well as climate-effective design of roadside greenery using a selection of plants adapted to climate change. The project team continues to support the municipalities' planning projects with their professional expertise regarding climate change adaptation, rainwater management and vegetation technology and will also further implement communication measures to raise the population's awareness of the intersection between spatial planning and climate change. The transferability of the demonstrations shall be guaranteed with the help of various regional, national and international exchange forums. The aim is to implement individual measures highlighted in the exploratory study in the municipality and to highlight the municipality of Strasshof as a pioneer and lighthouse demonstrator for other municipalities in the field of climate-adapted settlement and land use development.

4.1 Implementation of climate change adaptation measures in the municipality of Strasshof

Based on the project "Strasshof 2021", the project "Strasshof. Klimafit!" aims to implement resilient, multifunctional, and climate-fit solutions in the municipality of Strasshof that respond to heat and heavy rain, improve the microclimate, increase quality of life and living and promote biodiversity and species diversity on existing areas in the municipality, specifically through the following demonstrations, which will be evaluated by microclimatic and social scientific monitoring.

- A first implementation of EVAPO+ transpiring green walls: These green walls will be implemented as microclimate-improving measures which have been further optimised with regard to evapotranspiring cooling effects, leading to a better quality of life and supporting biodiversity.
- A demonstration of an innovative multifunctional nature-based biodiverse combination of a plant-based infiltration and water-saving basin as a measure to deal with heavy rain and as a contribution for sustainable rainwater management. The aim is to improve the local water balance through the performance of plants in combination with other techniques in order to ensure drainage security in the event of heavy rain events as well as to increase evaporation and essentially correspond to the natural water cycle. The saving and infiltration of water results in an innovative way of dealing with rainwater, as well as a cooling effect and an increase in biodiversity all of which can mitigate the negative consequences of climate change.

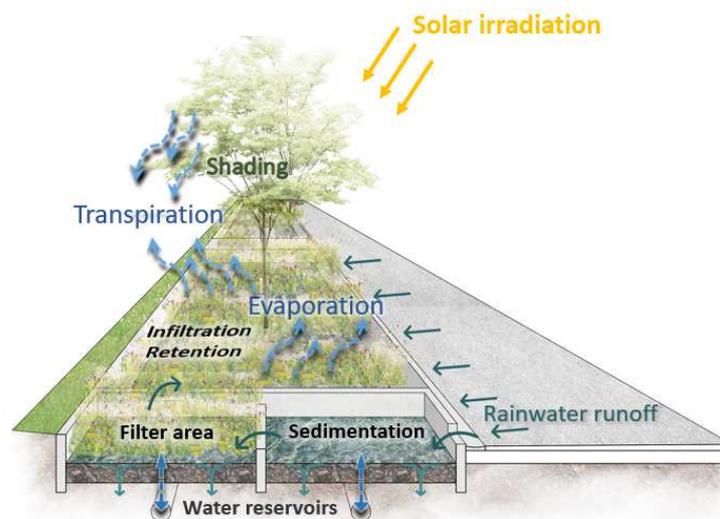


Figure 2: Concept visualisation for possible infiltration areas (Concept and visualisation: Dipl.-Ing. Ralf Dopheide e.U.)

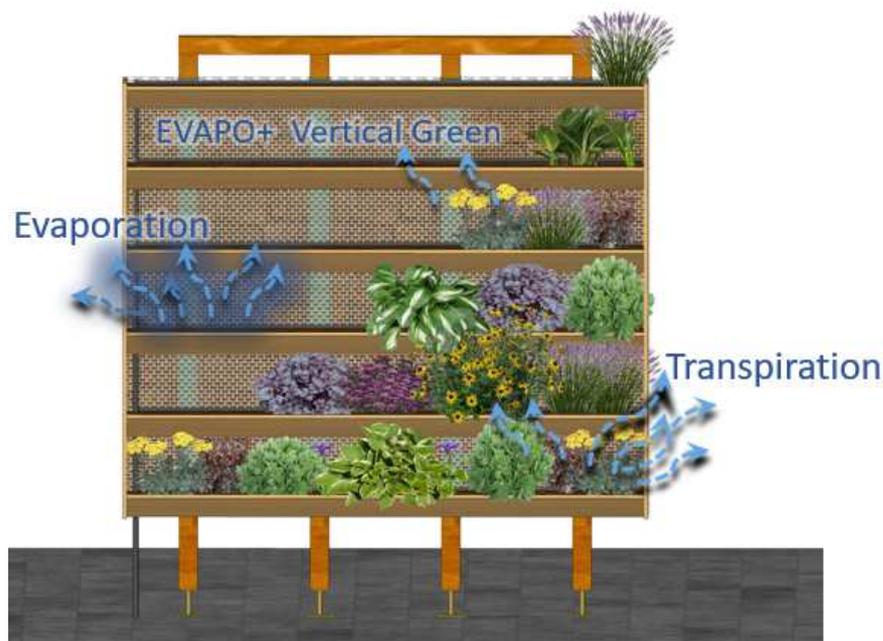


Figure 3: Concept visualisation for the EVAPO+ transpiring green walls (Concept and visualisation: Dipl.-Ing. Ralf Dopheide e.U.)

By targeted empowerment of the municipality, further demonstrative climate change adaptation measures on public, semi-public and private properties, emerging from the exploratory work, are initiated and supported. The municipality of Strasshof will be further supported in future construction projects to implement sustainable and climate change-adapted spatial development. The criteria developed for climate change-adapted development planning (§ 30 NÖ ROG) for usage models to improve the quality of life and living are taken into account. The implementation of the criteria in the development plan leads à la longue to climate change-adapted living conditions. The community is further supported in implementing examples of adaptation measures in public space, which can also be replicated for private space: To help raise awareness in the population, the feasibility and advantages of climate change adaptation measures are shown to the citizens through exemplary implementations in public spaces that encourage replication on private property (interaction between municipality and residents). Empowering the municipality to adapt to climate change means to popularize and promote intertwined fields of action between the community and citizens. The term "empowerment" reflects the circulating call for action between communities and private individuals. The authorisation to implement measures adapted to climate change is a process on the intertwined levels of the political and the private.

With all these measures, Strasshof can act against climate change consequences and improve the liveability of the population. Both the built demonstration measures and the empowerment of the community are intended to be lighthouse demonstrations and role models to promote climate-fit small towns and communities regionally, nationally and internationally.

4.2 Lighthouse demonstration for other municipalities

Other municipalities and small towns in Lower Austria, Austria and around the world are facing the same challenges and can benefit from this demonstration of measures for climate change adaptation in Strasshof. Therefore, "Strasshof. Klimafit!" can be considered as a lighthouse demonstration project that stimulates processes for climate change measures by empowering other municipalities and small towns. The transferability of the demonstrations will be supported by the project through various regional, national and international exchange forums: In cooperation with other Austrian municipalities, the lessons learned from Strasshof are reflected and transferred using a regional network "Climate Fit Small Towns and Municipalities" and step-by-step instructions for climate-fit municipalities. In the course of a steering committee, national and international exchange is also promoted. As a lighthouse demonstration for climate-fit municipalities, Strasshof is intended to create awareness and initiate processes for climate change adaptation measures in other communities.

4.3 Intended impact and results

The project puts the analysis results and proposed solutions into practice in the community of Strasshof. The following results and impacts are intended:

- Resilient, multifunctional demonstration measures for the combined improvement of the microclimate and the handling of rainwater are implemented on existing public areas and their effectiveness is evaluated. The built lighthouse demonstration measures are multifunctional and combine cooling with rainwater management and aesthetics/quality of stay. Existing technologies are combined and innovatively further developed.
 - First-time implementation of the EVAPO+ transpiring green wall and verification of its effects
 - Demonstration of an innovative multifunctional nature-based biodiverse combination of a plant-based infiltration and water-saving basin as a measure to deal with heavy rain and as a contribution for sustainable rainwater management and verification of its effects
 - Efficient, innovative and smart handling of rainwater as well as cooling effect and increase in biodiversity
 - Mitigation of negative consequences of climate change: heat and flooding due to heavy rain
 - The performance of plants as a "natural air conditioner" is made visible
- Empowering the municipality and raising awareness among the population - climate change adaptation specifically in my community (by providing answers to the question "What can I do?")
 - Implementation of exemplary climate change adaptation measures and actions in public space, which act as a guide for both the municipality and the population, encouraging climate-fit measures and imitation on public and private property
- Specification and climate change related adaptation in planning instruments, procedures and processes at municipality level (using the example of a community with a structured administration)
- Exemplary effect of the lighthouse municipality Strasshof for other municipalities regionally, nationally and internationally by showing the possibilities for climate change adaptation and exchange (transferability of the demonstrations)
 - Step-by-step guide to a climate-fit community
 - Action plan with specific recommendations for actions at international level

5 CONCLUSION

Both funded projects in general aim to promote a spatial, urban and land use planning that is oriented towards dealing with the consequences of climate change – mitigating existing problems and counteracting future problems resulting from climate change – not just in big cities, but also in smaller cities, towns and villages. The aim is to implement certain possibilities to act against climate change through spatial and landscape planning in the municipality of Strasshof, which should then lead as an example for other cities and towns, at least in Austria. The idea is to show clearly what can be done and that every action counts and to communicate that message and the relevant outcomes to different municipalities and local people. It will become more and more crucial to deal with heat waves and heavy rain and the preparations for that need to start now – both, in private property as well as in public space. Starting changes in public space helps to sensitize and inform the population of what can be done on private properties as well, which is important especially in smaller towns, where there are a lot of private garden grounds, which is why, especially there, they are as much as important as the public space. For the increased use of innovative greening technologies as a means of counteracting the increasing sealing, the level of local spatial planning should be applied. For both property types, spatial planning can induce a lot by effectively anchoring innovative solutions against climate change effects, such as greening (for example the greening of buildings) and sustainable rainwater management, into concepts and regulations of spatial planning. On the one hand, this can lead to a facilitation of actions, because often the bureaucratic way towards greening and infiltration measures is complicated and takes time. Ultimately, this should contribute to a simplified implementation of innovative greenery in spatial planning. On the other hand, some mandatory rules applying to all municipalities in

Austria would help immensely to forward the process towards more "climate-fit" cities, towns and villages, which, in the end, is very important for the wellbeing of every individual and for the entire environment.

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