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Challenges for Implementing Blue-Green Measures in the Transformation of Peri-Urban Streets

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1 ABSTRACT

The PeriSponge project is a three-year research project with an implemented prototype in Feldbach, a small town in the south of Austria. PeriSponge aims to improve potential hydrological retention areas and flood capacities along transport areas through well-designed, multifunctional and multicoded open spaces, while providing water management and quality of life solutions to improve climatic, ecological and social functions for quality sustainable peri-urban areas. The analytically applied research is being evaluated and will be made transferable to other cities. At this point, the project is at the end of the first project year.

Keywords: toolbox, blue-green measures, mobility open space, peri-urban, spatial planning

2 STATE OF KNOWLEDGE

Resilient urban areas need integrated planning and an frugal use of resources and land, while at the same time being liveable and of high urban quality (Degros & Bendiks, 2021). The idea of using resources and land as efficiently as possible is reflected in the context of urban sustainability, especially in the approach of multifunctionality (Jabareen, 2006). This applies even more to open spaces, which have to fulfil a multitude of requirements, from leisure and biodiversity to mobility and infrastructure, and which have to accommodate an ever-greater diversity of user groups (Becker, 2020) as well as climate change adaption measures. In order for such efficient use to succeed, urban planning and the design of open spaces must take on an important moderating role between the different sectoral plans in order to turn monofunctional and/or sealed infrastructure buildings, traffic areas, residual spaces, etc. into green-blue infrastructures for more quality of life and to be able to meet the overall demand for more green and open spaces (cf. Umweltbundesamt, 2021).

The impacts of already increased water-related events such as floods, droughts, water pollution, scarcity of biodiversity and pressure on high-quality open spaces in urban settlements, among others (Zandonella et al, 2013)are intensified by the steady growth of cities (Trenberth, 2011; O'Donnel and Thorne, 2020). Beyond the general focus on central places of the Urban, the 2005 UN Habitat report shows not only that 61% of the world's 5 billion population will live in urban areas by 2025, but more importantly that about 85% of this development process will take place in the urban hinterland, widely referred to as “peri-urban”, “suburban”, “outskirt” or “urban sprawl” (Prakash et al., 2011).

These peri-urban areas, which are largely car-dependent and lack urban infrastructure, are areas that have been created by economic, social and legal frameworks in recent decades. With the growth of sealed areas - especially on the periphery - a decoupling of spatial, hydrological, ecological and social needs and an increasing socio-ecological fragmentation of open space can be observed (Hecke, 2020).

This shows that these areas deserve more attention than they currently receive in general discourses on resilience, sustainability in urban planning and design.

3 TOOLBOXES FOR THE REDESIGN OF PUBLIC SPACE

In order to facilitate a systematic redesign of public space, a number of toolboxes, i.e. application-oriented planning aids focusing on the redesign of existing urban streets, have been developed (cf. BlueGreenStreets, 2022). The spatial focus of these planning aids is mainly concentrated on central urban areas such as inBerlin, Vienna, Hamburg, Zurich, Kassel, etc. (Stadtentwicklung Wien, 2011; Stadt Zürich, 2019; Umweltbundesamt, 2019).

These toolboxes were developed for the conditions of wide urban street spaces. The parameters of wide street spaces, such as historical, spatial local characteristics, allow a systematisation of redesign concepts. Above all, military, hygienic and representational purposes as well as the number of inhabitants were important factors why streetscapes were significantly widened. From the mid-19th century onwards, entire

districts and neighbourhoods were altered to create wide streets and boulevards in the urban structure, which are now subject of redesign measures to blue-green streets (cf. Degros et al., 2021). A second round of widening urban streets started with car-oriented urban planning schemes in the mid-20th century. In the search for space to implement blue-green elements for climate adaption, the research project Bluegreenstreets found that many streets in the urban study areas in different German cities had wider profiles than the nationally recommended minimum width. This additional space offers room for action in the transformation process to integrate blue-green infrastructure and recreational spaces, once the traffic shift is implemented.

Our study in small to medium sized towns in Austria, and there, on the outskirts of the cities, display on the contrary that many road widths mapped are even narrower than nationally suggested guidelines (ÖsterreichischeForschungsgeselschaftStraße-Schiene-Verkehr 2020) for sufficient dimensioning of road lanes and sidewalks. The historic road network were connections for agricultural and trading purposes and served as a national network for military operations in case of war. For these transport only uses, such roads were implemented with minimum widths. From the industrial age onwards, different functions and trades have settled along the historic road network. In the second half of the 20th century, these small trade and agriculturally driven cities saw more housing developments and commercial areas growing along the existing road networks while the narrow road widths remained. Agricultural or green areas were converted into sealed surfaces or parcelled out for single-family housing developments. With all the infrastructure created in parallel for this purpose, such as car parks, small garden settlements, agricultural land, cemeteries, etc., a mix of sealed, private and public and partly fallow land was created. Urban sprawl as well as such peri-urban sprawl puts high pressure on environmental resources, the developments "eat up" valuable natural habitats in the surrounding landscape (OECD 1990). However, this phenomenon affects not only ecological networks, but also publicly usable space. As the pressure for open space may not be comparable to dense centres, the heterogeneous character includes industries and commercial uses with workers and employees as well as units with apartment buildings and single family houses which all have a certain need for public space, may it be for recreation or socializing. On the other hand, urban and peri-urban sprawl also leads to interstitial and leftover spaces that are often private and socially underused (Mariani& Barron, 2014), This is particularly the case along the circulation areas of peri-urban spaces (Bendiks & Degros, 2019). Urban sprawl also reinforces the current dominant use of motorised transport of roads (cf. Umweltbundesamt).

Therefore, peri-urban spaces are particularly affected by a lack of quality publicly usable open spaces and a lack of valorisation of the few publicly usable spaces. They are also affected by heat stress caused by large sealed surfaces such as shopping centres and car parks (ÖROK, 2019).

These structural differences and challenges between urban and peri-urban space can only be addressed to a limited extent with the existing planning recommendations focused on inner urban streets and make the need for a toolbox for the peri-urban space all the more obvious. Literature is largely lacking, although peri-urban spaces are growing four times faster than inner-city spaces (cf. Piorr et al., 2011) and thus can and must make a significant contribution to climate change adaptation and mitigation.

4 THE PERISPONGE PROJECT – WATER, CITY, PEOPLE

The research project PeriSponge explores which potential streetscapes may have to contribute to a blue-green transformation of peri-urban areas. As public spaces are rather sparse outside central areas, infrastructures of mobility represent an important spatial resource for the implementation of blue-green elements. A blue-green transformation comes along with multifunctional benefits when aiming to make settlement areas more resilient for future challenges. Blue-green transformation means in the first place to introduce design principles for a decentralised local water management oriented towards sustainable local water cycles. Well-designed, multifunctional and multicoded (Becker, 2020) elements for water management in streets can contribute to provide rainwater retention for flood prevention, to keep rainwater for irrigation and vital urban greenery, to refill groundwater levels and last but not least to secure climate comfort for those using urban space by shading and cooling effects of trees and other vegetation (evapotranspiration) also in times of intensifying heat waves. The applicability and practicability of blue-green multifunctional designs for peri-urban streets will be tested and evaluated by means of a "prototype" implemented in Feldbach, Austria.

The choice of the implementation site of the prototype is derived from an analysis in three thematic levels: Water, City and People. The hydrological analysis defines danger spots where flood events and floods have occurred in the past and may occur in the future. Among other aspects, flow paths and slope waters are taken into account and possible areas for retention volumes are identified in order to store or retain rainwater. At the urban planning level, mobility, urban activities, green and open spaces, amenity qualities and sealed surfaces are analyzed. Gaps and missing spatial and ecological connections in the urban structure locate future areas for action. The hydrological and urban planning analysis are overlaid in the next step with local knowledge and show results for combined action needs in possible locations to integrate multicodedstreetscapes.

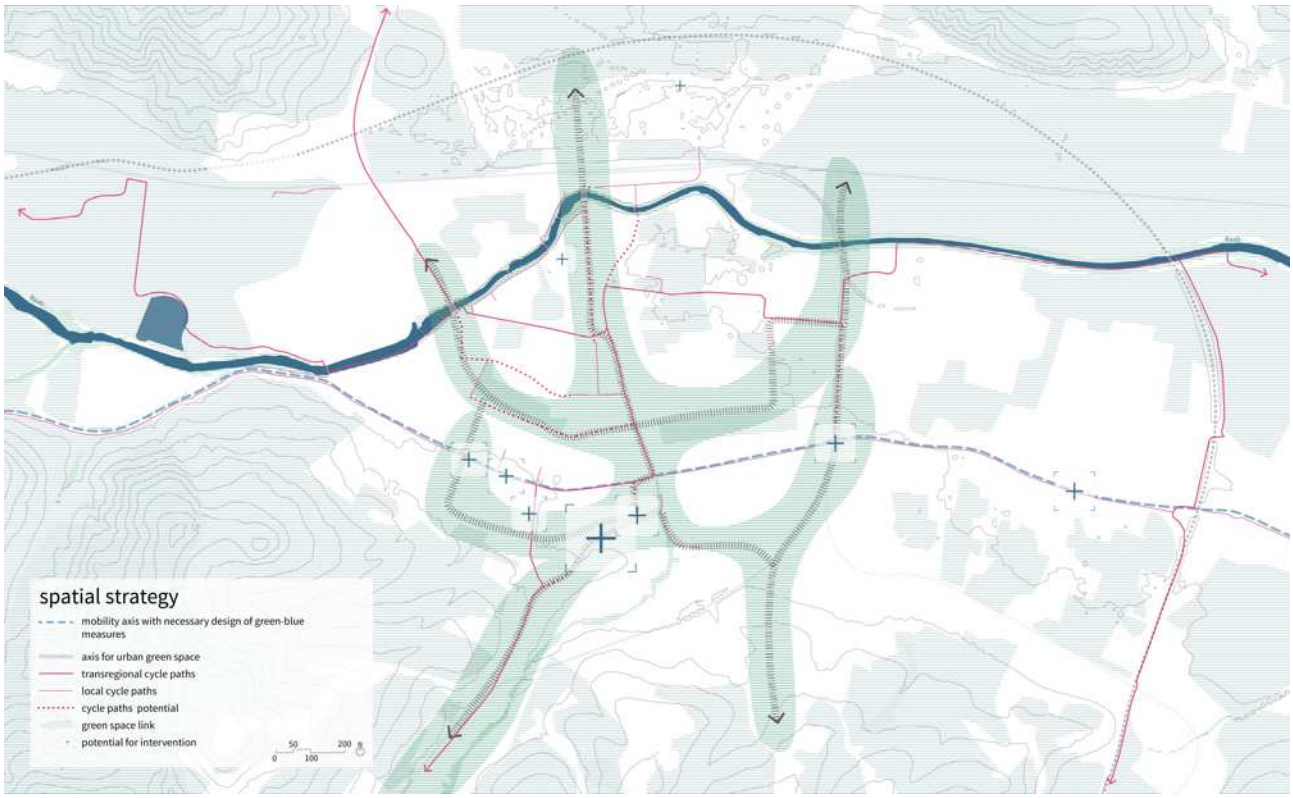

Fig. 1: Spatial Strategy Feldbach - overlaps for needs for action: potential project locations

The third level consists of the people, residents and interested parties, who are involved in the entire process. This serves to create awareness, a transparent design process in which wishes and suggestions are taken into account, and a resulting increase in acceptance among the population. Multicodedstreetscapes create additional spaces for people to stay. The scarce public space in the peri-urban area can thus be integrated along the streetscape. Naturally cooled and shaded areas can thus contribute not only to staying but also to pleasant movement with active mobility. This type of implementation supports the needs of adjacent residents and people moving in the peri-urban space.

In the design and implementation process, several events are offered in the project phases for further participation in order to communicate different design approaches and legal contents. After implementation, the prototype and its effectiveness will be analysed and evaluated.

From a hydrological perspective, the retention volume, the effectiveness of retardation/storage and the before/after effect of the microclimate will be evaluated, among other things. In addition, the degree to which rainfall events can be mitigated will be determined. From an urban planning perspective, the appropriation and acceptance of the new public spaces and their design will be evaluated. (Fig.2)

The project results will be used to develop transferable and scalable instruments, such as a practice-oriented toolbox and action guidelines for other peri-urban areas.

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Fig. 2: Participation process on project site in Feldbach (June 21, 2023) (c) Philipp Flachhuber, Institute of Urbanism

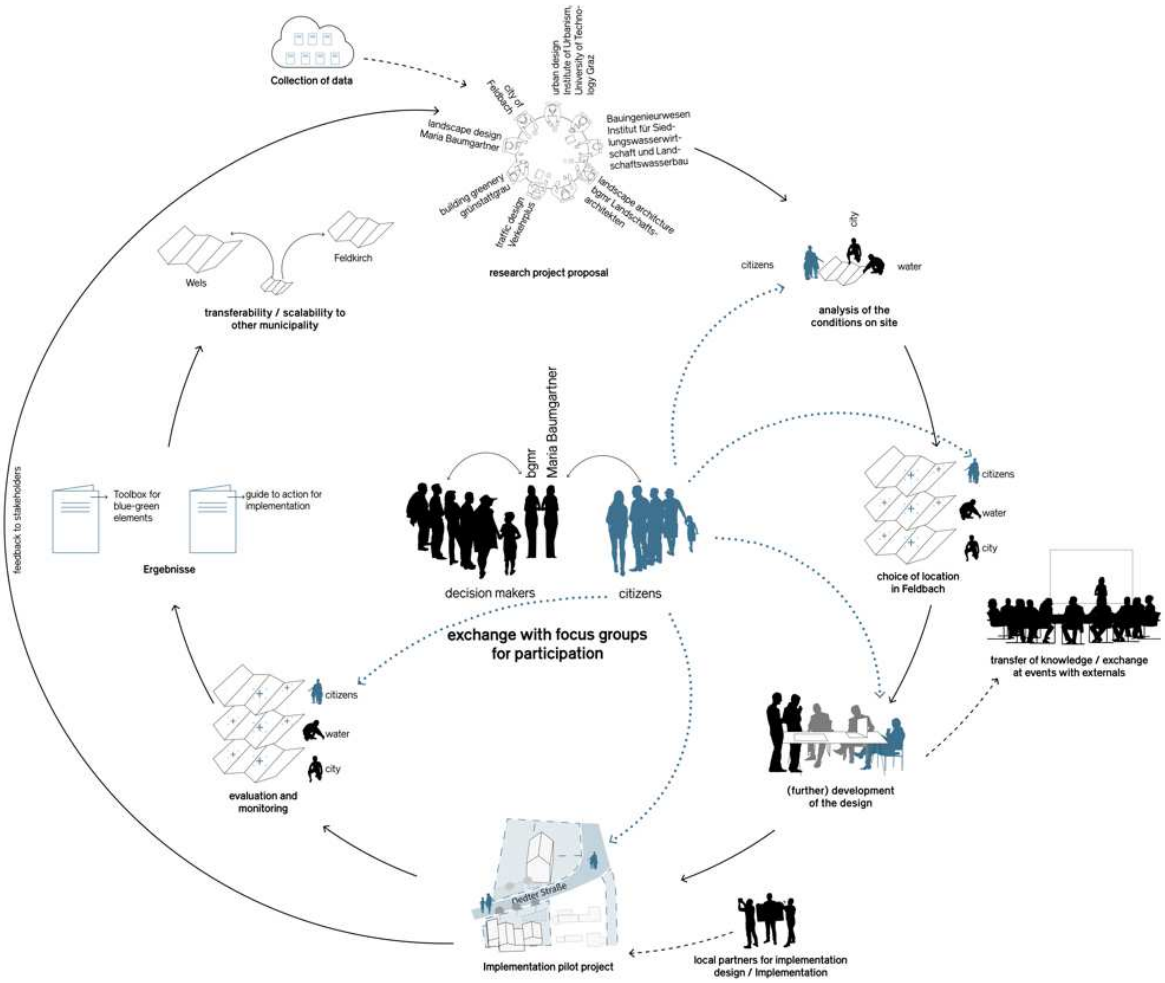

Fig. 3: Implementation Project PeriSponge Methodology

5 IMPLEMENTATION SITE FELDBACH, AUSTRIA

Feldbach is the fifth largest city in Styria with 13,371 inhabitants and is growing, especially on the outskirts (LandesstatisitkSteiermark, 2019). Pressure can be observed especially on the outskirts of the city, which is mainly due to the expansion of infrastructure and led to demographic change and increased immigration

Situated in a valley, Feldbach is located on an axis between south-eastern Styria and Graz and embodies a medium-sized and regional centre. Topographically, Feldbach is bordered by elevations from the north and south. The main river runs north of the old town. The geographical valley location of Feldbachfavours floods during heavy rainfall events, especially slope water from the elevations in the south enters the urban area along flow paths from the. south. The heavy rainfall events in the summers of 2017 and 2021 in particular caused major damage to settlement areas along the streams.

The long-established and the newly built streets in Feldbachhave different characteristics, but can be described as peri-urban. Long-established peri-urban streets have heterogeneous use and declining density, while new peri-urban streets have strong monofunctional commercial or residential use. Both types are seen as peripheral streetscapes that are subject to faster transformation than urban streetscapes.

In direct comparison, the streets around the old town of Feldbach can be described with urban parameters. This is mainly reflected in the denser development, closed building lines and heterogeneous adjacent functions. Likewise, some integrated cycle paths indicate a more urban structure. If Feldbach is considered as a whole, the peripheral streets cancategorised as peri-urban. However, if Feldbach is put in relation to large cities and urban centres, the majority of streets in Feldbachcan be seen as peri-urban.

Fig. 4: Implementation site Oedter Straße, long-established street on the outskirts of the city

In the rapid development of the predominant development type single-family house over the urban fringe areas in Feldbach, the creation of inner-city, multifunctional green spaces was neglected. The development of blue-green infrastructures and green spaces was mostly limited to aesthetic elements (as the design of the main square shows) or not pursued at all, as in the redesign of the roadside greenery on the main streets. As a result, progressive soil sealing, the decline of open spaces and extreme precipitation events repeatedly lead to hydrological problems such as flooding, but also to a drastic increase in temperatures and changes in the city's microclimate (Gangl, 2020). The streets in Feldbach fulfil the already mentioned characteristics of

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peri-urban streets, such as the too small or minimal street width, the high degree of sealing and too little green and public spaces.

6 INITIAL FINDINGS FOR A PERI-URBAN TOOLBOX

For the development of a peri-urban toolbox and a systematic redesign of existing streets, the first step was to categorize and analyse existing street network to show characteristics, usage patterns and spatial potential for transformation The findings are looked at from a systemic thinking to generate transferable knowledge and solutions.

The documented streets are analysed for the implementation of multicoded measures. Accordingly, not only potentials against flooding but also for natural cooling and quality of public space measures are examined. The latter are most likely to be integrated where most people flows take place. Schillerstraße functions as a transition between the old town and the peri-urban space of Feldbach. The total of 78 documented streets is located north and south of it. Peri-urban space per se has different functions, monofunctional residential streets are thus excluded from the documentation.

The 78 streets were photo-documented and categorised according to FRC (Functional Road Class). The number of lanes and directions of travel, number of adjacent pavements, bicycle lanes, vehicle parking areas and adjacent ground and upper floor uses were documented. Most of the streets are classified in the sixth category, that of collector streets. Most of these streets have only one lane, which can be used in both directions. Some of these streets have parking areas for motor vehicles, and rarely have pavements on both sides.

This category has the most roads and therefore has the largest surface area. Most collector roads have very small cross-sections and therefore a correspondingly low spatial potential for redesign, if traffic change is not considered.

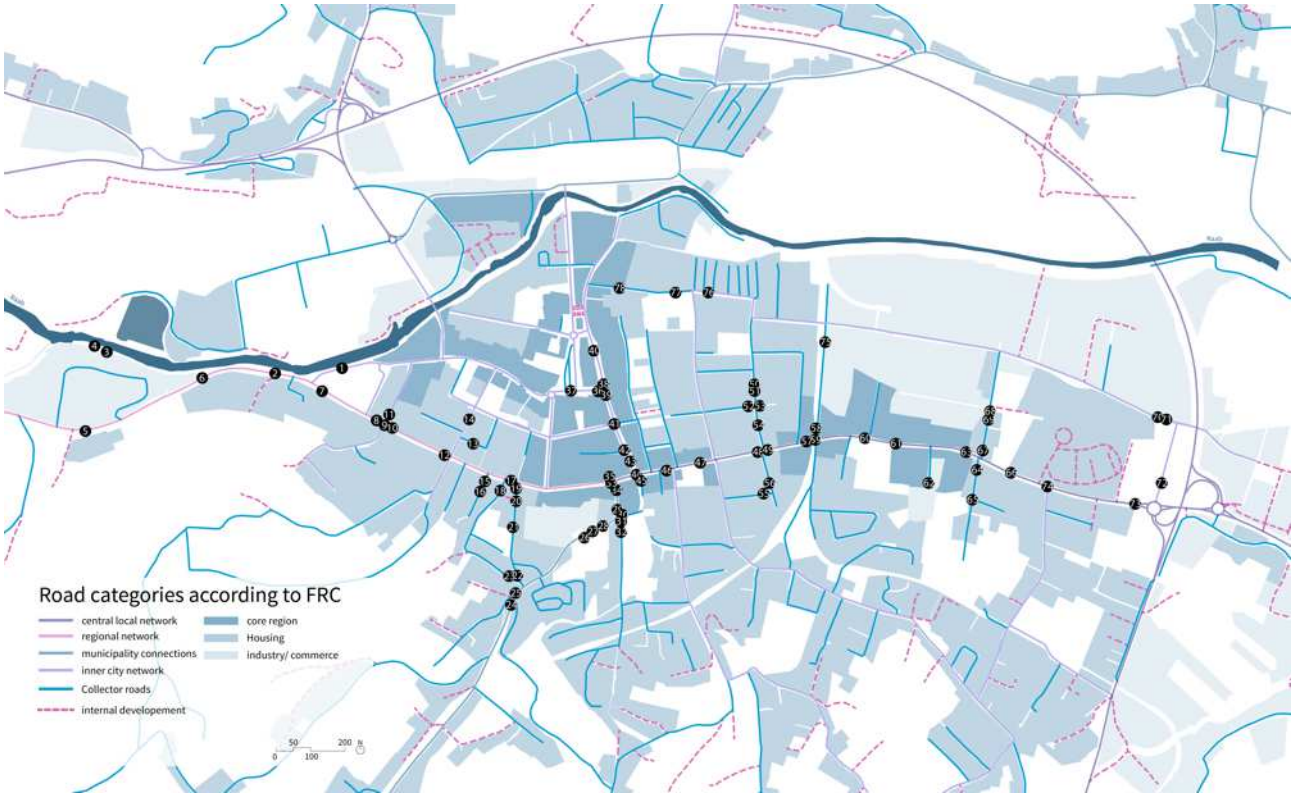

Fig. 5: Road documentation in Feldbach

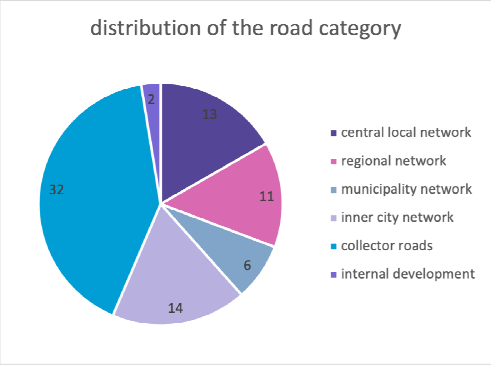

Fig. 6: distribution of the road categories in Feldbach according to FRC

(1) Central local network: Supraregional connections between district capitals or from district capitals to the provincial capital. Connections from district capitals to other employment, supply and tourism centres (13 documented streets)

(2) Regional network: Regional connections of municipalities or parts of municipalities to district capitals. Regional connections of municipalities or parts of municipalities to other centres of employment, supply and tourism (11 documented streets)

(3) Municipality connections: Small-scale and local connections between municipalities or parts of municipalities.(6 documentedstreets)

(4) Inner city network: Other local connection functions (14 documented streets)

(5) Collector roads: Connects service roads in residential or commercial areas to a main road (32 documented streets)

(6) Internal development: Connection to a building plot (2 documented streets)

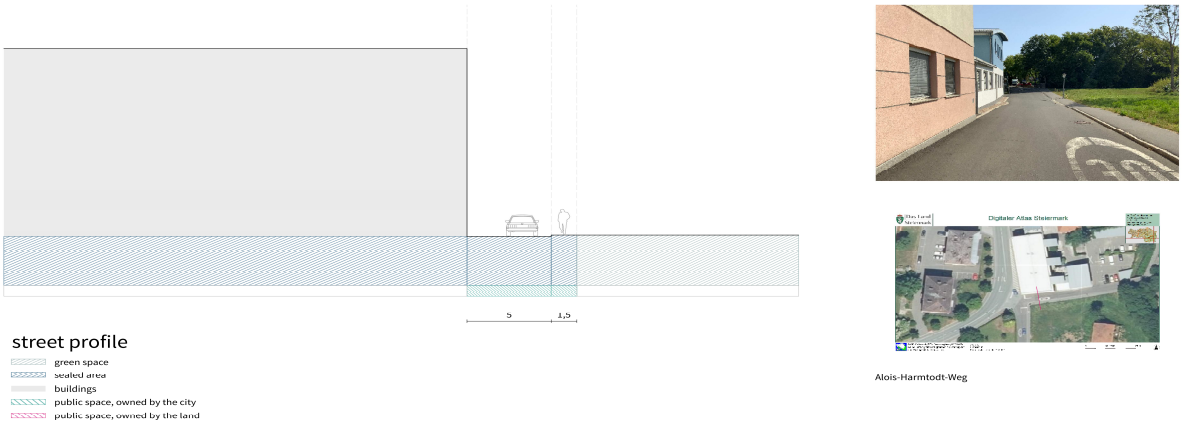

Fig. 7: Example of collector street: nr30 – Alois-Harmtodt-Weg

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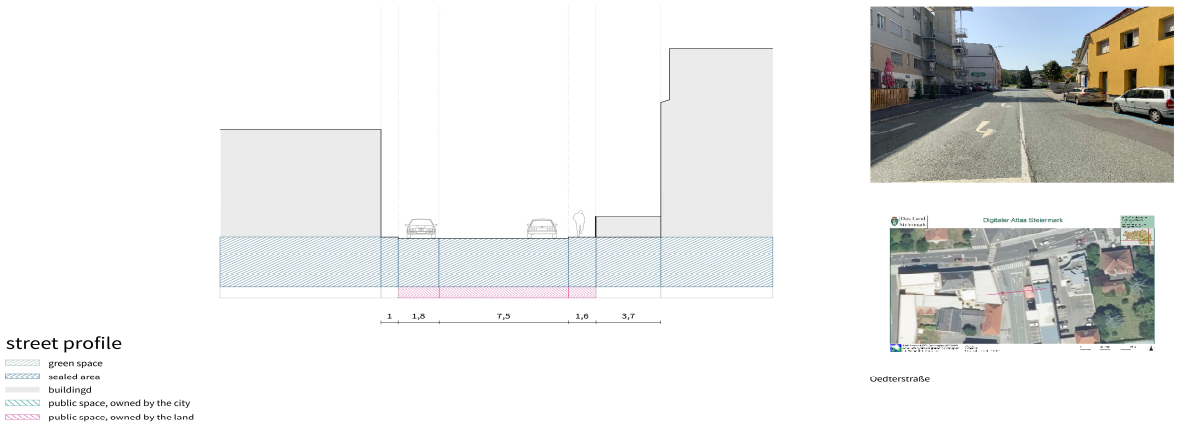

Fig. 8: Example of municipality connection: nr34 – Oedter Straße

6.1 Need for changes in mobility policy

The prioritisation of motorised traffic on the narrow cross-sections results in a monofunctional design of the street space. A spatial separation between active mobility, such as walking and cycling, and passive mobility, motorised traffic such as public and individual transport, for example, often only find space in current practice where the cross-section allows for implementation. In order to achieve an implementation of the design of multicoded mobility open spaces, the transformation process has to be linked with the mobility turnaround. This is the only way to defuse the prioritisation of motorised traffic and activate sufficient areas for the implementation of blue-green infrastructures.

6.2 Planning beyond property borders

In the development process of the demonstration project in Feldbach it became apparent that the limited public street space at the implementation site of a peri-urban street cannot fulfil sufficient retention tasks in terms of area. In order to solve the existing heavy rain problems and to achieve a large retention effect, planning beyond the street boundary is inevitable. The limited public street space alone cannot bear the demands of rainwater management. For the greatest possible positive effect, you need cooperation and coordination with the adjacent neighbours. As in the demonstration project, this implies cooperation with many private actors, like a large commercial enterprise with large sealed areas, the cemetery, a large area with little green space quality, a municipal housing development, a social facility for young people and private property owners. In the coordination process, current projects or wishes of different agents must be included in order to be able to implement a project beyond property boarders. For the communication process with and between the agents, the local knowledge, which in small towns is bundled directly in the administration, must be used. From previous experience, it can be assumed that it is similar in comparably sized municipalities, as the administrative structures are the same. Our role as scientists and planners is mainly to guide which actors need to be brought to the table in order to implement blue green infrastructures. In this specific case, an attempt is being made to transform a road, which is administered by the province of Styria, but is located in the municipal area of Feldbach, which adds another administrative level that requires additional effort in terms of financial coordination, responsibility and approval.

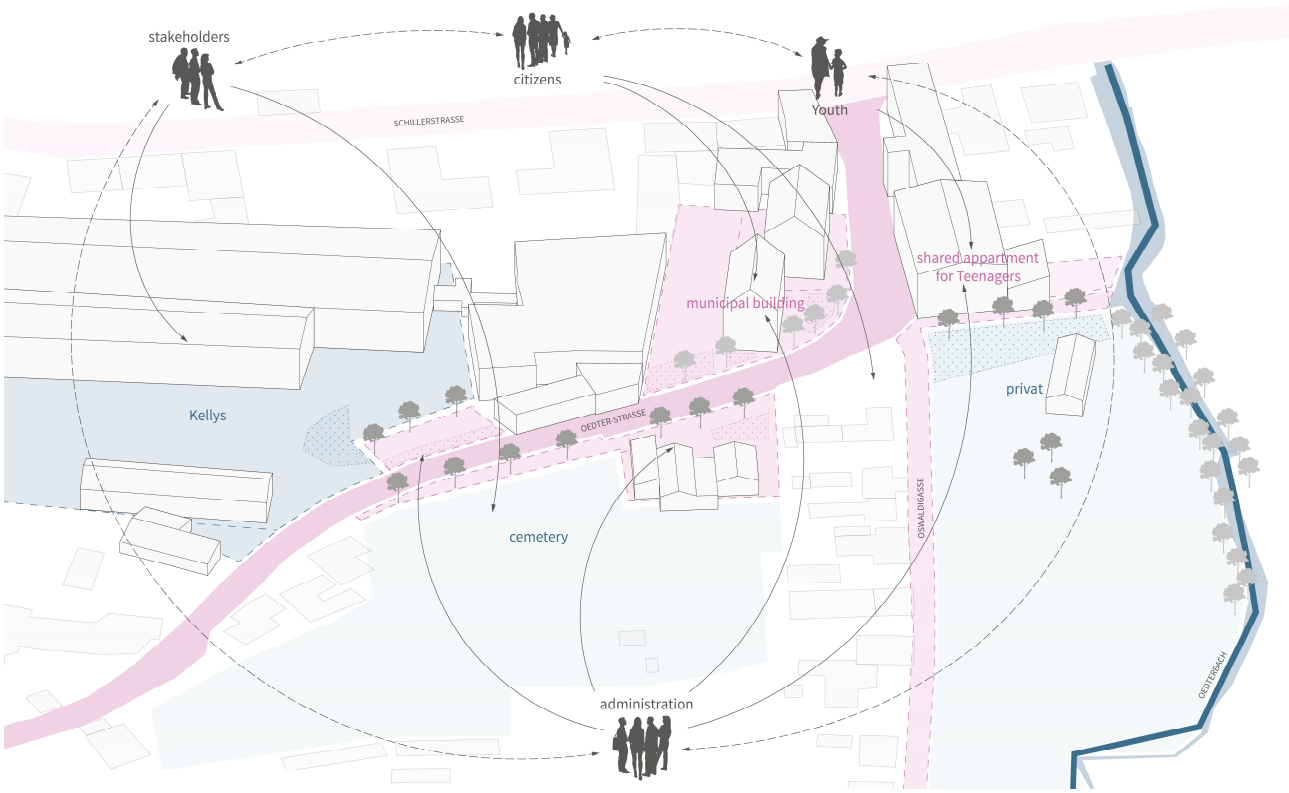

Fig. 9: planning beyond property boarders at the Feldbach implementation site

6.3 Administrative challenges

The administration in small and medium-sized towns is often limited in terms of staff and faces additional challenges due to the complex, multidisciplinary tasks and the large number of actors. Another issue is that specific data is often not captured or older data is not yet digitised, which can slow down the work process if not planned for. Administrative tasks are often handled by only a few people in small towns. When important decisions hangon a single person, they can quickly be put off by more urgent tasks, for example when heavy rainfall events and consequent flooding occur. In the disaster phase, the importance of new projects thus quickly recedes into the background. The quality of the implemented projects is thereforenot only dependent on the way the administration works, but also on the local implementing companies. The novelty of the topic of creating multicoded spaces in the peri-urban space and the interdisciplinary work in the scientific context of a research project result in new ways of working for the municipality and local companies, which are to a large extent outside their previous practice and can thus cause uncertainties about the results.

Nevertheless, an advantage of municipalities is that the administrations know the local conditions well, can process orders quickly and react more flexibly than in the administratively complicated apparatus of big cities.

6.4 Thinking in strategies

In case of the pilot onOedterStraße, the research project defined five climate adaptation strategies. These strategies were derived from the local conditions. Nonetheless, due to the representative peri-urban mix of functions and road typologies in the project area, the strategies hint towards transferable solutions for peri-urban streets in general:

- Road repartition to gain space for blue-green climate-adaptive elements: through traffic calming, reduction of roadway widths according to goals for transformation of mibility patterns, to gain green and retention space determine
- Decoupling of public and or private parking lots along the street from the storm water channnels: through decentralized infiltration measures on side to relieve the pressure on the canal networks
- Decoupling of buildings or ensembles along the street from the storm water channnels: through decentralized infiltration measures on side to relieve the pressure on the canal networks

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- Adjustment of road slopes for emergency waterways targeted drainage of slope water: through modification of road profiles
- Wetlands and/or rainwater retention areas: through identification of suitable propably underused adjacent spaces along the streets such as brownfields, underused parking lots, undeveloped land, gaps or other, preferably in public property or in chance for purchase

These strategies highlight the need to plan beyond property borders in often narrow peri-urban streets. This first strategies developed within the pilot project will be extend through a set of micro strategies for more central urban streets, that already have got some green elements like road trees. In many cases, such existing elements can be transformed into small elements for a climate-adaptive road network through relatively small interventions. These interventions could be to remove edgings of tree beds and create flat depressions in order to uptake rainwater. These two approaches for small scale and easy interventions together with bigger transformative measures hint towards a comprehensive goal for the blue-green adjustment of the wholeperi-urban road network on the long run, starting now.

6.5 Multifunctionalityand urban quality

The technical rain water solutions always need to be thought and planned along integrative goals for usable and comfortable public space. Streets and their ancillary spaces make up a significant part of the public realm especially in peri-urban areas. The major challenge of climate-adapted transformation of streetscapes therefore goes beyond purely functional tasks. Even though retention and infiltration areas are engineering facilities for water management objectives, it is necessary to consider them in the context of the public space in terms of design and to integrate social and aesthetic aspects. They should contribute to the spatial quality of the place. This means applying multifunctional planning principles. A retention basin can be designed as a park at the same time, a planted infiltration bed can enhance the green and open space, a row of trees the streetscape.

7 CONCLUSION

These points are of decisive importance for a transformation of mobility spaces in the peri-urban space. At the same time, the turnaround in mobility policy and the transformation of the public space in which it takes place must be thought about and developed together. The transformation must be integrated in the holistic system and cannot be part of an individual single solution.

With the prototype in Feldbach, we are testing how such a transformation can be implemented. The project already shows that new constellations of actors are needed. The approach of thinking beyond the plots creates an extremely local solution. Is it at all possible to make these approaches transferable to other cities or transferable at all?

How can the approaches developed be made scalable? What would a project look like that envisages transforming Feldbach's 10 most important gateways, also in terms of coordination with the province of Styria, budget, personnel, etc.?

The current issues and requirements for the project and the planned implementation show that it is essential to work together on approaches to solutions that are becoming increasingly relevant in the current challenges of spatial transformations (cf. Armengaud, Degros et al. 2023).

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