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ReBioClim

D1.3.1

REPORT ON SOCIAL-ECOLOGICAL SYNERGIES AND CONFLICTS IN THE CASE STUDY AREAS

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1. Introduction

The challenge of urban stream restoration can be described in terms of competition for space. Urban infrastructure and built-up area limit the size of area available for restoration in urban areas. Nevertheless, nature-based approaches offer the opportunity in limited urban settings to combine ecological restoration goals and social benefits via enhancement of ecosystem services – but their application strongly depend on stakeholder's advocacy and citizens' appreciation.

To raise awareness and increase the knowledge of all stakeholder groups on the role of ecological restoration of urban streams to promote biodiversity, climate adaptation and urban life quality, ReBioClim aims to restore urban streams in a citizen-centred approach with nature-based approaches based on scientific findings that incorporate the urban-spatial, stakeholder and ecological perspectives.

The following report will elaborate on a method to synthesize those different perspectives in a way to identify synergies and conflicts for the restoration of the pilot section of the four ReBioClim streams using nature-based approaches stream/river, city, country):

- Bílá Nisa, Jablonec nad Nisou, Czechia
- Geberbach, Dresden, Germany
- Piaśnica, Poznań, Poland
- Teplica, Senica, Slovakia

From a social-ecological perspective, all proposed measures bring benefits to urban ecosystems, biodiversity and quality of life. This fact serves as the basis for the assessment of the synergies and conflicts. This is done in a quantitative assessment of the spatial demand for a specific social-ecological restoration action, expressed via spatial condition (SC) and the public support (PS) for this intervention in each case study area (Figure 1).

The ecological, social and spatial attributes used in this analysis were retrieved from the results of the following ReBioClim deliverables:

- **D1.2.1** Ecological goals for the restoration of the study streams
- **D1.2.2** Citizens' preferences towards specific restoration measures considered for implementation
- **D1.2.3** Report on the spatial composition, configuration analyses and assessments of ecosystem services
- **D2.1.2** Co-Design Workshop Report

All these documents are available on the project website: https://www.interreg-central.eu/projects/rebioclim/?tab=outputs

This report can therefore be seen as the synthesis of the multi-perspective analysis of stream restoration in our pilot areas. The main goal is to identify synergies and conflicts between ecological restoration goals (D1.2.1), the citizens' perspective (D1.2.2) and urban spatial analysis (D1.2.3).

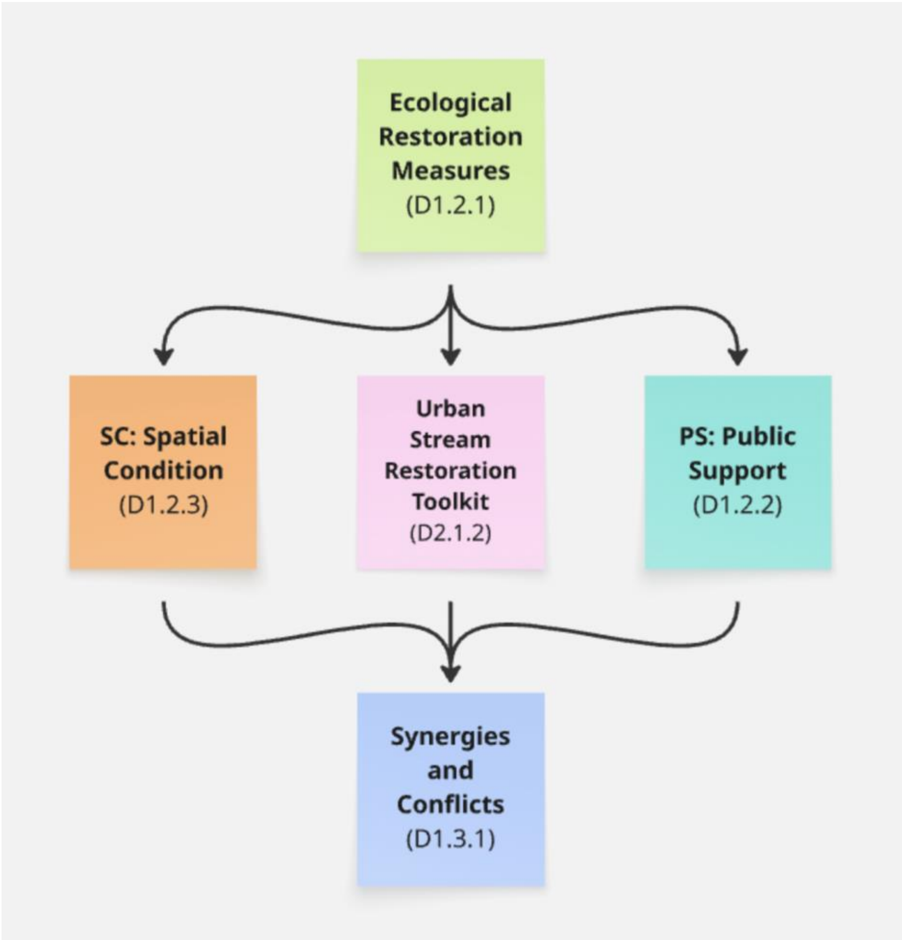

Figure 1 Diagram showing the relationship between the three perspectives used to derive synergies and conflicts and corresponding deliverables.

2. Methodology

Considering the complexity and richness of the three perspectives to be brought together, we employed a mixed-methods approach to deriving synergies and conflicts using the following workflow:

1. Select ecological restoration measures and prioritise them based on the number of usages in the co-design workshops (D2.1.2),
2. determine the spatial unit of the analysis,
3. identify the variables related to spatial conditions and public perception for each measure,
4. standardise all data to a 5-level classification ranging from 1 (very low) to 5 (very high) and
5. identify Synergies/Conflicts by comparing the spatial condition and public support on pilot site level.

2.1. Selection of ecological restoration measures

The basis for the synergies and conflict analysis was a set of 36 restoration goals identified in D1.2.1 that followed setting up driver, pressure, state, impact, response relationship (DPSIR framework) for the pilot streams. The DPSIR framework is not only used but is recommended as a best practice for stream and river restoration in both scientific literature (Song et al., 2012; Lu et al., 2019; Pinto et al. 2013) and international restoration projects (WISER Project, REFORM Consortium, Global Water Partnership). For the case study sites, the most common pressure types related to urbanization, hydro-morphological alteration and climate change were selected based on WFD Reporting Guidance 2016 (Annex 1A), which presents a list of pressures relevant in European freshwaters (EC, 2015). The related responses (restoration goals) were based on findings of REFORM project, that analysed the effect of restoration measures across Europe.

For each restoration goal, we identified a set of possible restoration measures with a description of the effect on climate adaptation, biodiversity, and quality of life. We used this dataset as a basis for the toolbox developed within ReBioClim to support the co-design workshop methodology. As urban stream health is the starting point for our restoration efforts, the ecological restoration measures served as a reference for assessing spatial conditions and public perception.

When calculating synergies and conflicts, we wanted to ensure that the ecological restoration measures are rooted in what local experts consider necessary. Accordingly, we used the results of the co-design workshops to rank the restoration measures by how often workshop groups addressed them with cards from the toolkit (D2.1.2). After ranking them, we discarded all ecological restoration measures used 3 or fewer times, reducing the number of measures from 36 to 27. Because the threshold was relatively low and only seven goals were excluded, this reduction does not significantly affect the comprehensiveness of the remaining set of measures.

2.2. Unit of analysis

One of the challenges in the analysis of synergies and conflicts was making the results from the three perspectives comparable, that is, using the same spatial unit. For the spatial unit, we chose on the one hand the **50m stream sections** of the stream, because it provided the highest level of detail, as well as **the whole pilot site**, aiding comparability with public-perception variables that are not stream-section-specific.

2.3. Selection of Variables

We identified variables describing the spatial condition and the public support corresponding to the formulated ecological restoration measures. We then characterised the status quo of the pilot sites via values derived from spatial analysis and structural mapping and derived values for public perception from the analysis of citizens' preferences for specific restoration measures considered for implementation, based on questionnaire and choice experiment results (D1.2.2). Some of the measures proposed as part of the identification of restoration goals (see D1.2.1 and column 1 of Table 1) were not evaluated in the public surveys or no corresponding parameters from the structural mapping or spatial analysis could be matched; therefore, we indicated "NO DATA AVAILABLE" here. The resulting set of variables is listed in Table 1.

Table 1 List of restoration measures and the corresponding variables representing spatial conditions (including the reasons for their selection) and public support.

Restoration Measure	Measure Abbreviation	Variable Spatial Condition	Reason for choosing the variable for the spatial condition	Variable Public Support (PS) (*3)
Provide access into the stream	Access_Stream	Accessibility to the water	This variable directly ranks the accessibility to the water on a 5-step scale from very good to not possible.	Access to water - stairs and pier (a)
Integrate programme e.g. leisure, education, swimming etc.	Integrate_Programmes	Point of interest (*1)	The number of related programme's points of interest that include leisure, education, sports, etc., representing the opportunities for multifunctional purpose.	Education, inspiration, casual contacts and recreational opportunities (c)
Enable nature observation	Nature_Observation	Bench count (*1)	The bench installation provides infrastructure and spots for wildlife observation and leisure.	Observing nature (d)
Remove wastewater inflow and stormwater run-off	Reduce_Pollution	Visible bank pollutions	This parameter includes the occurrence and frequency of rainwater and wastewater discharges.	NO DATA AVAILABLE
Add in-stream structures (dead wood, stones)	Instream_Structures	Stream Bed (Main Parameter)	This combination of different stream bed parameters, including substrate and its diversity, the degree of the occurrence of special bed structures or bed constructions, gives insight into the need for structural improvements.	Isles, water terraces, stones, dead wood in the stream (b)
Remove concrete channel, Installation of fascines where necessary	Remove_Concrete_ Channel	Mean of stream bed structure and stream bank structure	This combination gives insight into the degree of existing technical channel constructions, including the stream course and profile, the stream bed, the base of embankment and the stream bank.	Concrete stream (b) (*2)
Public space facilities	Public_Space	Livability of the area	The livability indicates how willingly and extensively people spend their leisure time at the stream. It includes the frequency of attractive seating areas, historical elements, educational trails, rubbish bins, sports facilities and so on.	NO DATA AVAILABLE
Ensure continuous service buffer	Service_Buffer	Mean of stream bank structure and stream environmental structure (*1)	This combination covers especially the condition of the base of embankment and the land use and vegetation of the stream bank and environment. It thus enables conclusions to be drawn about the current functionality of the buffer strip.	Arrangement of greenery in the wider area and riparian vegetation (a)

Restoration Measure	Measure Abbreviation	Variable Spatial Condition	Reason for choosing the variable for the spatial condition	Variable Public Support (PS) (*3)
Add groynes, baffles, dead wood and circulation trees	Groynes_Baffles_DeadWood	Special bed structures	Special bed structures is a parameter assessed in the stream structural mapping It can be none (very low), few (medium) or many (very high) and provides a rough overview of the current presence of such structures.	Dead wood (b)
Unseal impervious surfaces	Unseal_Surfaces	Impervious cover (*2)	The impervious cover represents the percentage of surfaces that are sealed.	Urban park (a) as proxy for impervious surface (*2)
Install monitoring station	Monitoring_Station	NO DATA AVAILABLE	NO DATA AVAILABLE	NO DATA AVAILABLE
Provide accessibility towards the stream	Accessibility_To_Stream	Slow mobility network intersection (*1)	The number of intersections between stream and slow mobility road network (cycle and pedestrian) of each section to represent the routes from urban areas towards the stream corridor.	NO DATA AVAILABLE
Remove technical riverbed	Remove_TechRiverbed	Percentage of stream sections where 10 to 100% of the stream bed are (technically) constructed	Classified in 20% steps, this variable directly corresponds to the need for removing technical constructions.	Meanders with/-out elements (a)
Add transversal green corridor	Green_Corridor	Mean of vegetation left/right (stream bank) and Land use and vegetation left/right (stream environment) (*1)	This variable provides information on the current status of vegetation along the stream banks and in the surrounding area, as a contribution to transversal green corridors.	Habitats for plants and animals (c)
Construct raingarden	Raingarden	Land use and vegetation left/right (stream environment) (*1)	This variable assesses the current land use and vegetation in a 50 m wide stripe on both sides of the stream. It gives information on the current presence of wet biotopes or can be used to evaluate the opportunities to construct raingardens.	NO DATA AVAILABLE
Increase space for river and floodplain	Increase_Space	Distance from stream to building	Mean distance between stream and the closest building for every 10m along the 50m section, which indicates the available space that can be further developed as stream corridors to reduce downstream flooding risk.	Meanders with elements (a)
Fine sediment retention	Sediment_Retention	Bed substrate / diversity	This parameter assesses all present sediment types.	NO DATA AVAILABLE

Restoration Measure	Measure Abbreviation	Variable Spatial Condition	Reason for choosing the variable for the spatial condition	Variable Public Support (PS) (*3)
Remove in-stream barriers	Remove_Biological Barriers	Continuousness (for aquatic organisms)	Continuousness assesses the barrier effect of transverse facilities as well as bed constructions without a sediment cover on a three-point scale ranging from 'no' via 'limited' to 'yes'.	Fish passage (b)
Installation of garbage cans	Garbage_Cans	NO DATA AVAILABLE	NO DATA AVAILABLE	NO DATA AVAILABLE
Create an interconnected network of green spaces	Green_Network	Mean of Vegetation left/right (stream bank) and Land use and vegetation left/right (stream environment) (*1)	This variable provides information on the current status of vegetation along the stream banks and in the surrounding area, as a contribution to an interconnected network of green spaces.	Wide riparian vegetation and natural arrangement of greenery in the wider area (a)
Use permeable pavement	Permeable_Pavement	NO DATA AVAILABLE	NO DATA AVAILABLE	NO DATA AVAILABLE
Provide accessibility along the stream	Accessibility_Along_ Stream	Slow mobility length (*1)	Slow mobility length indicates walking and cycling path possibilities along the stream.	Get from "A to B" (d)
Reconnect floodplains	Reconnect_ Floodplains	Environmental structure (*1)	This combination of different stream environmental parameters, including land use and vegetation or pollutions of the water's edge areas, gives insight into the degree of naturalness of the area.	Pools and wetlands in floodplains (b)
Plant riparian trees	Riparian_Trees	Canopy cover	The tree cover in the riparian zones (10m buffer on both sides of the section) represent the current riparian tree cover, which is related to shading on waterbody.	Improvement of microclimate (c) (as proxy for the added value of tree)
Plant riparian vegetation (bufferstrips)	Riparian_Buffer	Mean of vegetation left/right (bank) and river buffer strip 3 m (environment)	This variable assesses the vegetation at the stream bank and the adjacent buffer strip.	Wide riparian vegetation (b)
Plant fruit trees/bushes and herbs	Fruit_Trees	Occurrence of fruit trees/bushes and herbs	The occurrence of fruit trees/bushes and herbs in a 50 m wide stripe on both sides of the stream is based on a separate mapping.	NO DATA AVAILABLE
Safety: "Eyes on the stream!"	Safety	NO DATA AVAILABLE	NO DATA AVAILABLE	NO DATA AVAILABLE

*1 In 50m buffer on both sides of the section.

*2 Value was inverted.

*3 The letters in parentheses (a), (b), (c), (d) indicate the part of the questionnaire from which the values were taken - see Section 2.4 for more details.

2.4. Standardisation of values

To make the spatial condition (SC) and public support (PS) variables comparable across perspectives, we classified them on **a 5-level categorical scale** using the values **very low (1)**, **low (2)**, **medium (3)**, **high (4)**, and **very high (5)**.

Data describing the **spatial condition** based on structural mapping according to Renner et al. (2015) was already assessed using a 5-level index scale. But we had to invert this data, because an original index of 1 indicates a very good status, whereas an original index of 5 indicates a completely anthropogenically impaired status. For data resulting from the spatial analysis, we assigned the final scale class by comparing each stream's mean variable value to the class thresholds derived from the full distribution of all section-level values across the four streams. Based on the performance of each variable, if it is positive, the highest value corresponds to a very high scale (e.g., riparian canopy cover), whereas if it is negative, the scale is assigned inversely (e.g., impervious cover).

We extracted the values representing **public support** from four parts of the questionnaire results. We derived the main variables reflecting residents' preferences for stream revitalisation from the choice experiment (a), in which preference scores for attributes and their levels were calculated from model coefficients (ranging from approximately −1.33 to 0.7 across cities). We standardised these coefficients so that strongly negative values corresponded to levels 1–2, values around zero to level 3, and positive values to levels 4–5 according to their magnitude. For additional measures not included in the choice experiment, but still relevant for capturing residents' preferences, we derived values from a question in which respondents rated specific stream features on a scale from 1 to 10 (b). We reclassified these into the five-level scale, where low average scores corresponded to lower levels and high scores to higher levels of preference. Additionally, for some measures, we included values from Likert-type questions: (c) preferred ecosystem services (importance of potential benefits, original scale 1–4) and (d) usage types (main reasons for visiting the site, original scale 0–3). We also standardised these variables to a five-level scale using their average values. For some restoration measures identified in the ecological goals and co-design workshops, there was no unambiguous equivalent in the public perception survey, but multiple variables could be assigned to this measure. In such cases, we calculated the average of the relevant variables from the public perception survey. In general, the values of specific variables from the public opinion poll (see Table 1) can be interpreted as indicating whether and to what extent the public supports implementing this measure. If the public support score is greater than 3, it means that, from the public's perspective, this is a measure they would like to see implemented along the river. If the value is lower, it means there is not a strong public support for these measures. In cases where measures have high ecological added value but low public support, this signals to urban planners and city officials that they should better inform the public about the benefits of these measures to increase their acceptability.

2.5. Synergies and conflicts

To identify synergies and conflicts of urban stream restoration, we assessed each proposed restoration measure using the two dimensions already mentioned: spatial condition (SC), representing the current need and suitability for ecological restoration, and public support (PS), reflecting stakeholder preference and acceptance of the measure. We grouped the five-level scores into low (≤ 3 – for SC; < 3 for PS) and high (> 3 – for SC; ≥ 3 for PS) categories and classified measures into four quadrants (see Table 2). When both SC and PS were high, we interpreted the result as an actual synergy, where favourable ecological and spatial conditions align with stakeholder preferences and primarily require maintenance and protection. When SC was low, which means that restoration is needed, and PS was high, we identified a potential synergy, representing a strong restoration opportunity, as interventions are likely to be well accepted. When both dimensions were low, we classified the situation as an actual conflict, indicating poor ecological conditions combined with limited public support, and therefore a need to prioritise awareness-raising as a first step before restoration can be effectively planned. Finally, when SC was high, but PS was low, we identified a potential conflict, reflecting a perception gap that can be addressed through communication and stakeholder engagement to prevent future trade-offs. We first assessed spatial conditions and public support at the pilot-stream scale by calculating the mean values of all 50 m stream sections within each pilot stream. To interpret spatial variability across stream sections, we also examined visually the mapped variables showing section-level differences.

Table 2 Classification of synergies and conflicts according to the difference between SC and PS scores.

SC	PS	Conflict or synergy for restoration	Quadrant Location	Quadrant Name	Explanation/ Interpretation
>3	≥ 3	Actual synergy	Top right	Recognized asset	Good spatial condition or high spatial availability, which aligns with public support and preferences -> no awareness-building needed, maintain and protect spatial condition
≤ 3	≥ 3	Potential synergy	Top left	High restoration opportunity	Current spatial condition is low and public support is high -> strong potential to implement restoration measure that aligns with public perception and acceptance
>3	< 3	Potential conflict	Bottom right	Perception gap	Current spatial condition is good, but it is disliked or undervalued by the public -> need to inform about the benefits to prevent conflicts
≤ 3	< 3	Actual conflict	Bottom left	Information and restoration gap	Current spatial condition is bad (restoration needed) but public support is low -> restoration wouldn't be accepted, awareness-building is needed first

3. Results

3.1. General results

The analysis carried out for synergies and conflicts in our four pilot areas allowed finally classify 17 of 27 total analysed restoration measures (Figure 2). By far the most common measures in all analysed cases were assigned to the category *potential synergy* (quadrant *High restoration opportunity* in Figures 3, 5, 7 and 9). This category included 10 restoration measures in Geberbach and Teplica and up to 14 in Piaśnica and 15 in Bílá Nisa. The second largest group was the category *actual synergy* (quadrant *Recognized asset*). Only few restoration measures were classified as categories of *actual* or *potential conflict* (quadrants *Information and restoration gap* or *Perception gap*). Detailed analyses for each case study are presented in the following sections (3.2-3.5).

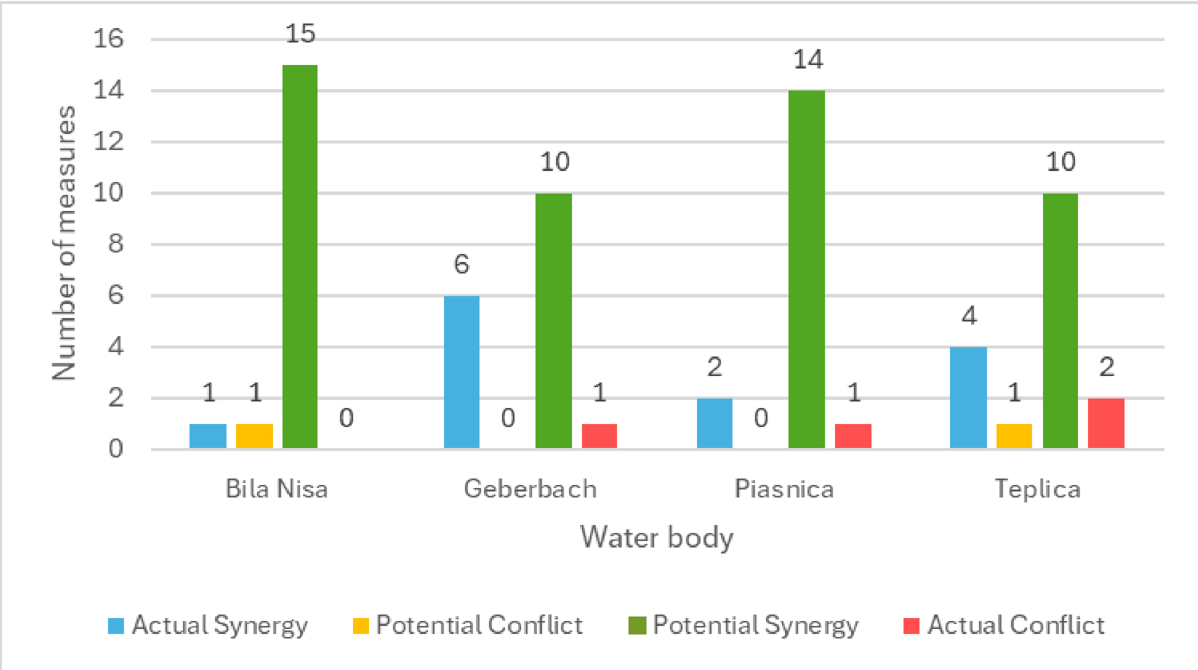

Figure 2 Number of classified restoration measures for each stream.

3.2. Bílá Nisa, Jablonec nad Nisou, Czechia

In Jablonec nad Nisou, there is a great opportunity to implement nature-based measures to restore the urban stream Bílá Nisa and surrounding. Most of 17 classified restoration measures fall into the category of high restoration opportunity (green colour in the Figure 3). This means that people support the introduction of many environmentally beneficial restoration measures (the green labelled measures in Figure 3), which are needed from a spatial perspective, as the current conditions are low to moderate. This is the case, for example, with riverbed (measures *remove technical riverbed*, *remove concrete channel*) but also facilities for *nature observation and leisure time*. Also, *accessibility along stream* can be improved in priority considering the bad spatial condition and the high public support (Figure 4). More walking and cycling path should be created along the stream corridors to enhance continuous public *access along the stream*.

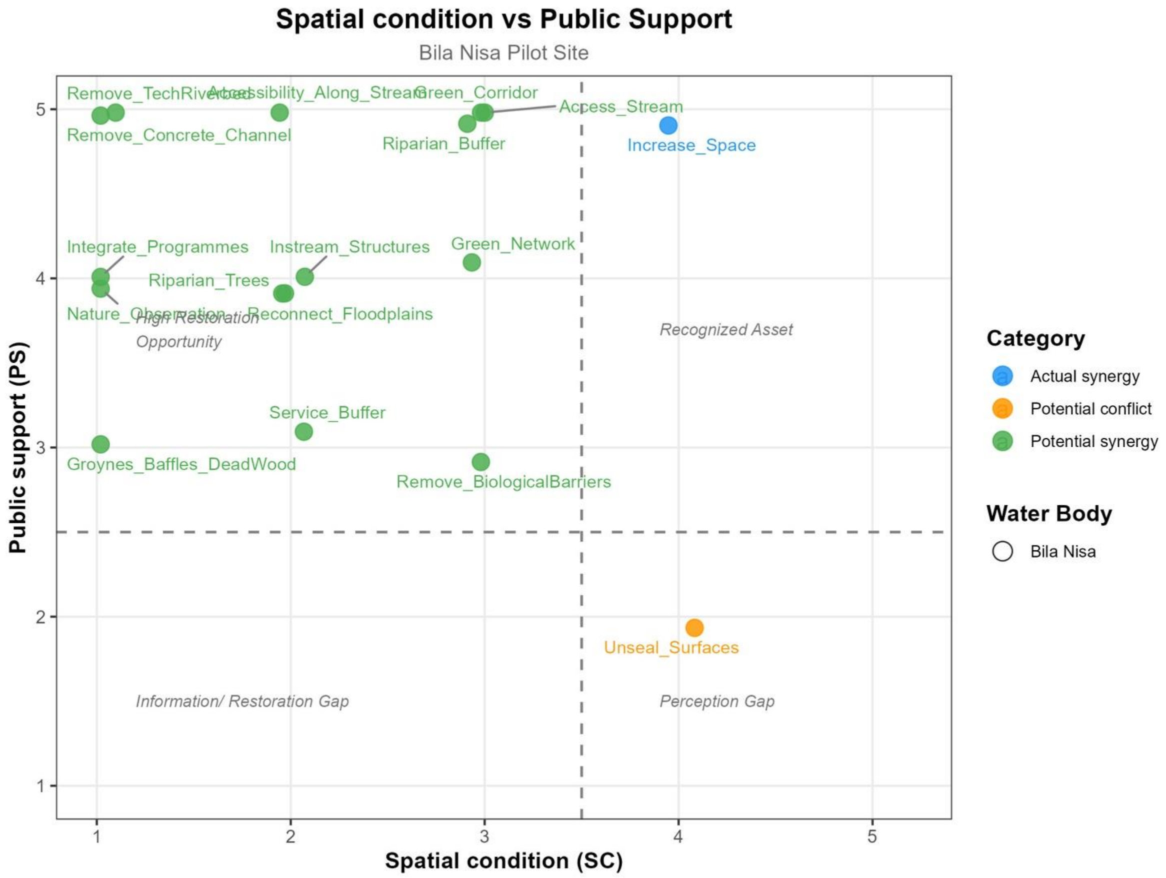

Figure 3. Distribution of spatial condition and public support values for the Bílá Nisa pilot stream, shown in a quadrant structure (according to table 2).

Only the measure *increase space for river and floodplain* is both considered high in spatial condition and public support (that means there is high public support for this measure and already a good current spatial condition). At the same time, it is necessary to inform residents about the benefits of *unseal impervious surfaces* to increase acceptance of this measure (as people do not view it as necessary, even though it brings significant benefits to both nature and society).

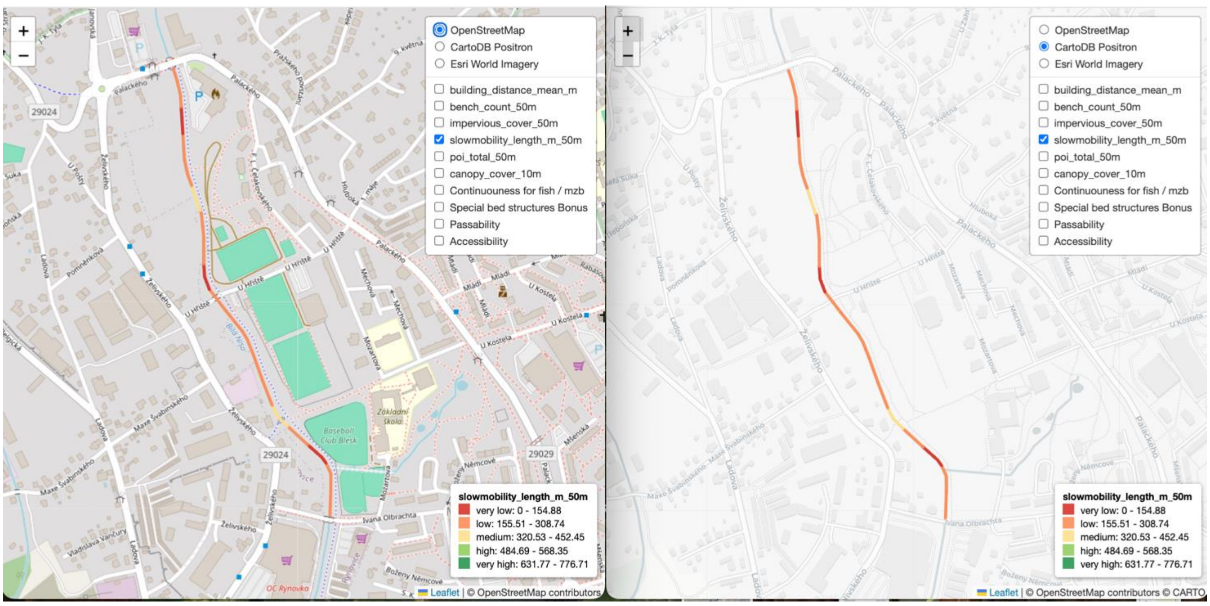

Figure 4 Maps of Bílá Nisa showing the values of slow mobility length at the 50m section level.

3.3. Geberbach, Dresden, Germany

For Geberbach, many restoration measures are highly supported by the residents, but the related current spatial conditions are to be improved (green measures in the Figure 5 valuated as potential synergy). For example, the *nature observation opportunities* are highly supported, but the current spatial condition, with the indicator of bench numbers around the streams, is very low. This suggests more nature observation infrastructures to be created to provide people with more opportunities for wildlife observation and leisure. Two other examples are the *green corridors* and *green networks*, which have a high to very high perception. For these measures the conditions for implementing them are even better, as some green spaces already exist (medium status), thereby reducing the effort required for restoration.

Dresden has also the high number (6) of clearly synergistic measures (marked in blue)—that is, measures that are strongly supported by residents and, from a spatial perspective, already have good performances on the related spatial conditions.

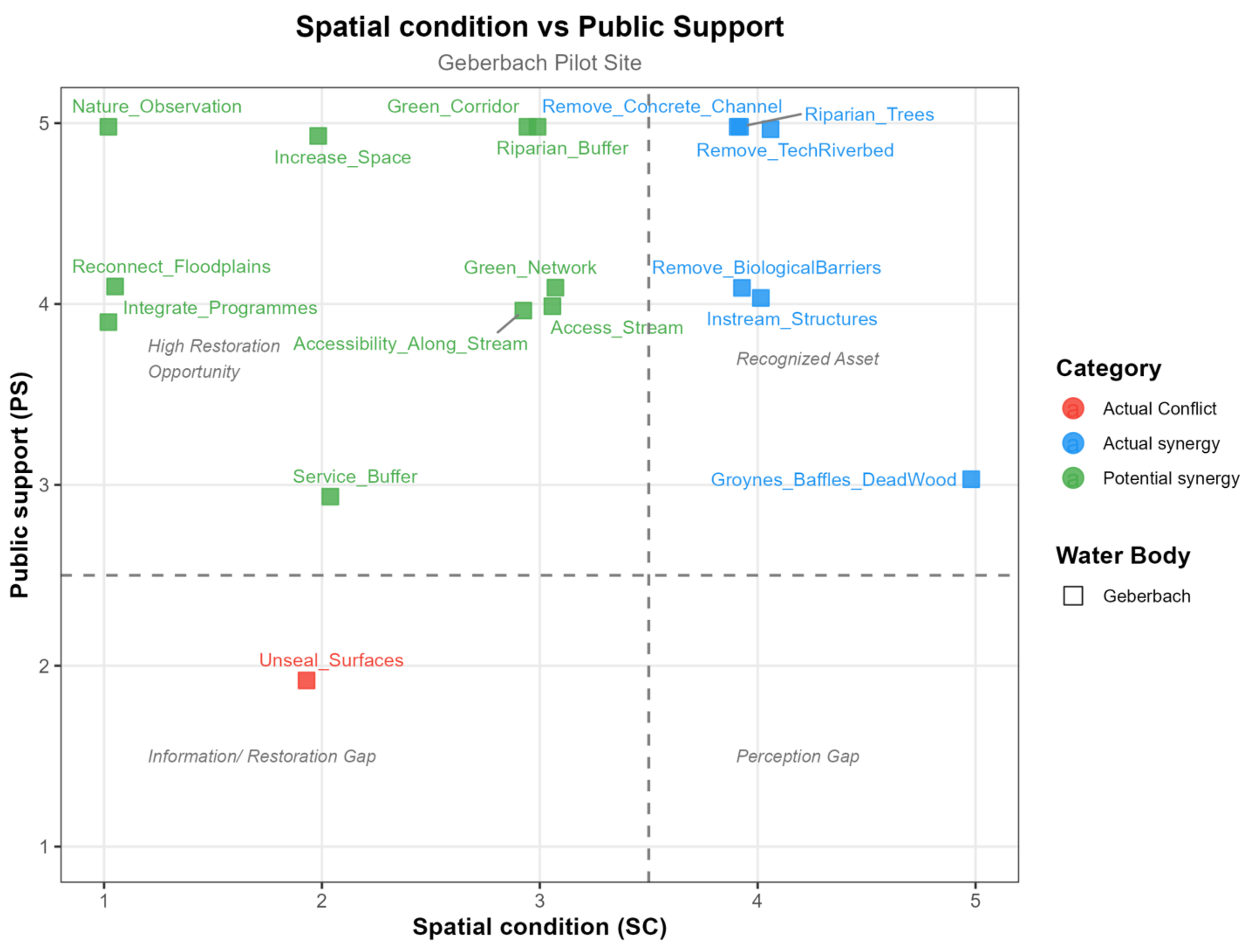

Figure 5. Distribution of spatial condition and public support values for the Geberbach pilot stream, shown in a quadrant structure (according to table 2).

The actual conflict occurs for the measure *unseal surfaces* (Figure 6), where the spatial condition and public support are both low. From the spatial perspective, the stream corridors, especially two streams of the pilot sites in the southern Geberbach have more impervious surfaces and if the city wanted to meet environmental goals, they should be unsealed. From public support perspective we asked the people about their preferences towards arrangement of greenery in the wider area of the stream whether they prefer the area to be designed as a nature-based park (wild plants, less frequent mowing, fewer paths), a semi-natural park (partial management of the area), or an urban park (characterized by frequent mowing, regular, often paved paths, flower beds with flowering plants, artificial planters, etc.). People in Dresden tended to prefer an urban park, which suggests that removing impervious surfaces along the river is not a priority for them.

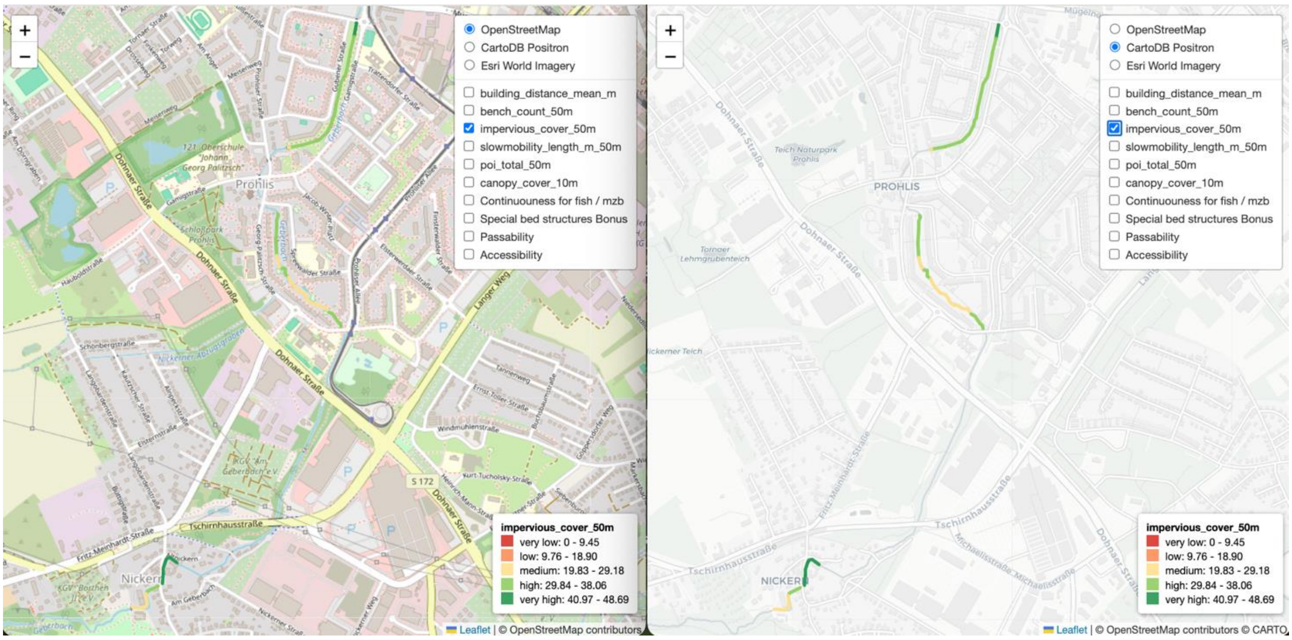

Figure 6 Maps of Geberbach showing the values of impervious cover at the 50m section level.

3.4. Piaśnica, Poznań, Poland

In the case of the Piaśnica stream, the spatial status of most measures (82% of all classified measures) is assessed as poor (Figure 7), because within the pilot site we are dealing with an underground section of the stream. This means that these measures are not currently in place at the given location, or their implementation is relatively challenging from a spatial perspective. However, they enjoy moderate (e.g., *removal of biological barriers*, *Introduction of a program*) or even very high levels of public support (e.g., *riparian trees*, *removal of technical structures in the riverbed and channel*), which tells urban planners and decision makers that their potential implementation is likely to be accepted by the public. These are the measures marked in green in Figure 7.

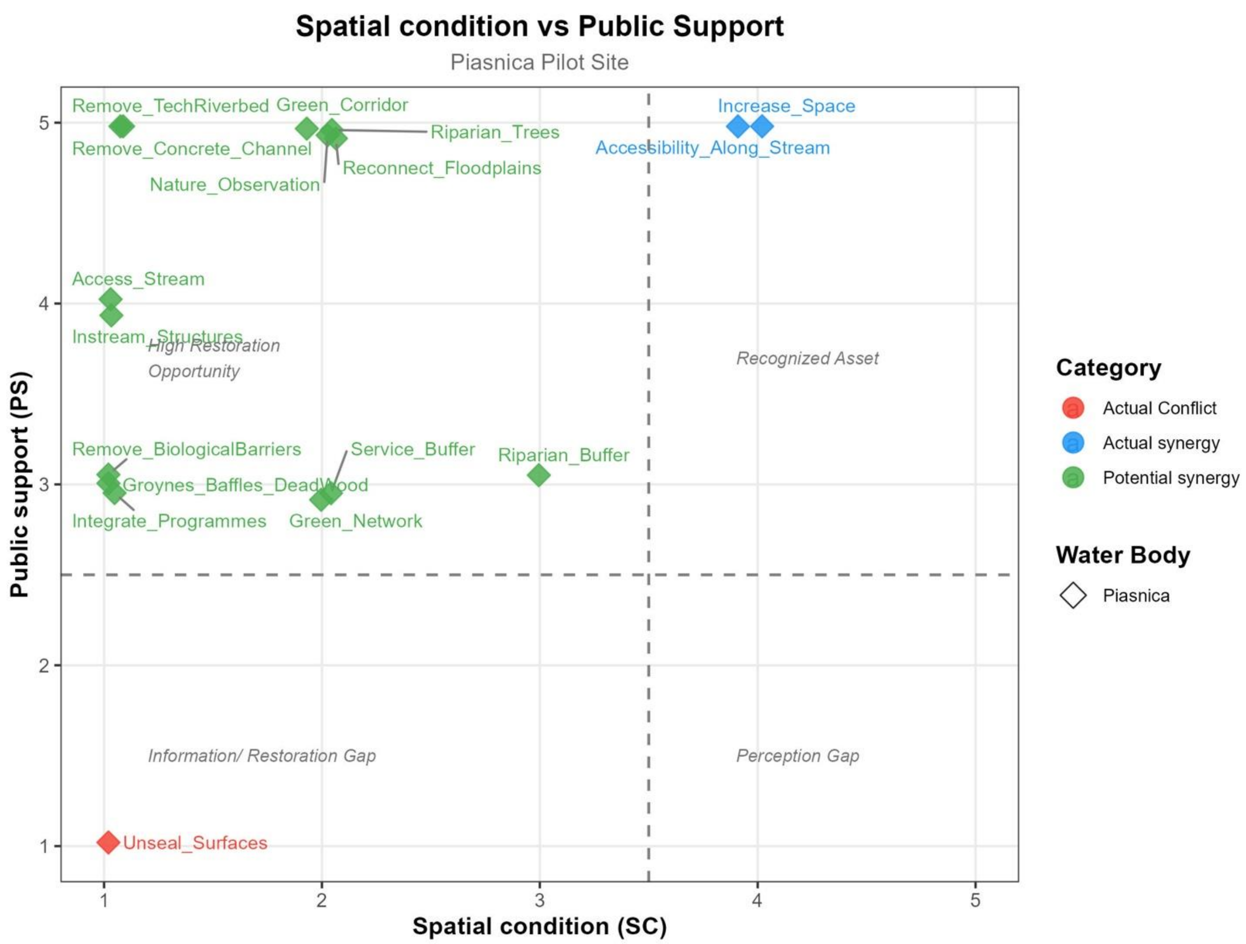

Figure 7. Distribution of spatial condition and public support values for the Piaśnica pilot stream, shown in a quadrant structure (according to table 2).

Regarding the measure *plant riparian trees* (Figure 8), although there is a high coverage of grass surfaces along the stream, the trees planted are relatively few. The spatial condition is very poor, but the measure is very highly supported by the public. Given that the pilot site in Piaśnica is underground, planners can use our data as a reference decide if more trees are to be planted along the stream.

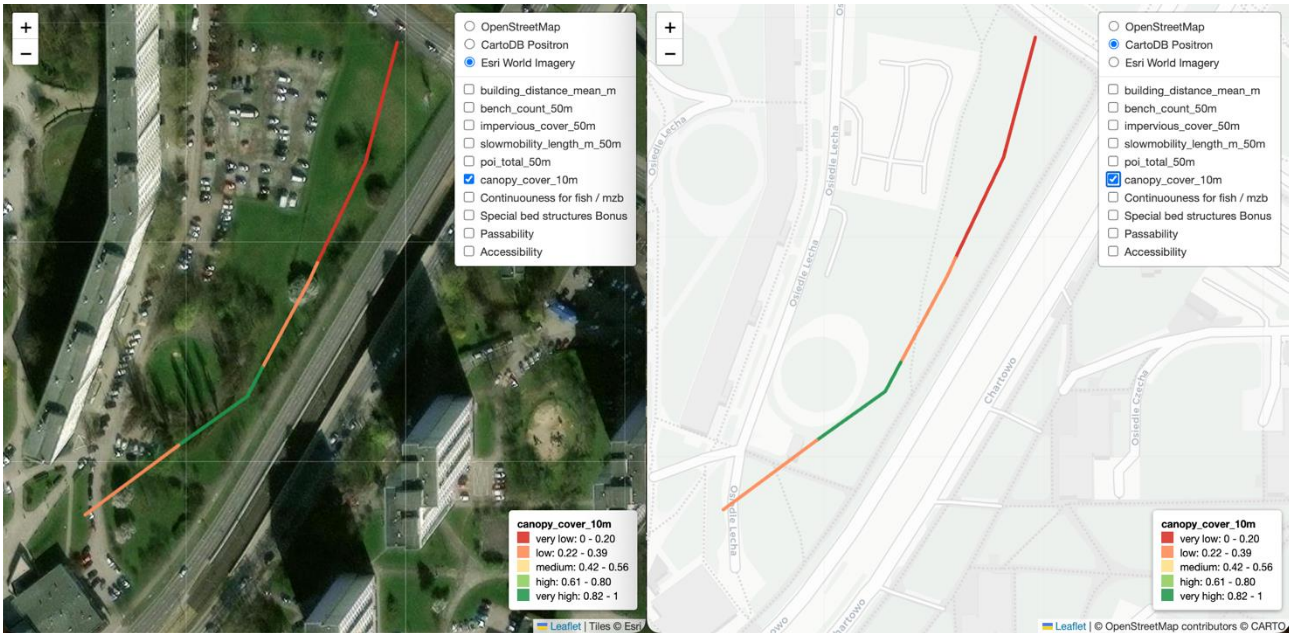

Figure 8 Maps of Piaśnica showing the values of riparian canopy cover at the 50m section level.

The actual conflict between ecological perspective and the other two perspectives (spatial and social) occurs for u*nseal surfaces*, where both spatial condition and public support are rated the lowest (both=1). From a spatial perspective, the high level of impervious surface coverage is primarily attributed to the surrounding main and internal road networks, as well as the presence of a large parking area. From the public perspective, removing impervious surfaces is not as high a priority as other measures.

Actual synergies exist for the *accessibility along the stream* and an *increased space for the stream and floodplain*. Given that the stream runs underground in a culvert, the latter one represents the spatial potential following the stream's reopening.

3.5. Teplica, Senica, Slovakia

In Senica, Slovakia, near the Teplica River, people support the introduction of many environmentally beneficial measures. Especially strong support can be observed for *Remove Concrete Channel*, *Green corridor* and *Increase space* with moderate spatial condition and *Riparian trees* and *Accessibility_Along_Stream* with accordingly very high and high SC (Figure 9). In total, the largest group are measures from the category "potential synergy (10 – marked in green colour). It is worth noting the diversity of this group in terms of public support.

What also stands out is the relatively high number of measures (4) which clearly showed actual synergies between ecological, spatial, and social perspectives (measures marked in blue, such as *Planting riparian trees*, *ensuring accessibility along the stream*, or *removing technical riverbed structures*).

For Teplica, the actual conflict between ecological perspective on one side and the spatial and social perspective on the other side, occurred for the red labelled measures – *creation of interconnected network of green spaces* or adding *dead wood, groynes or baffles in the stream*. This can be interpreted in the way, that those ecologically beneficial measures are not in favour with public perception (that means better information about the benefits is needed) and at the same time, the spatial condition for these measures are rather poor.

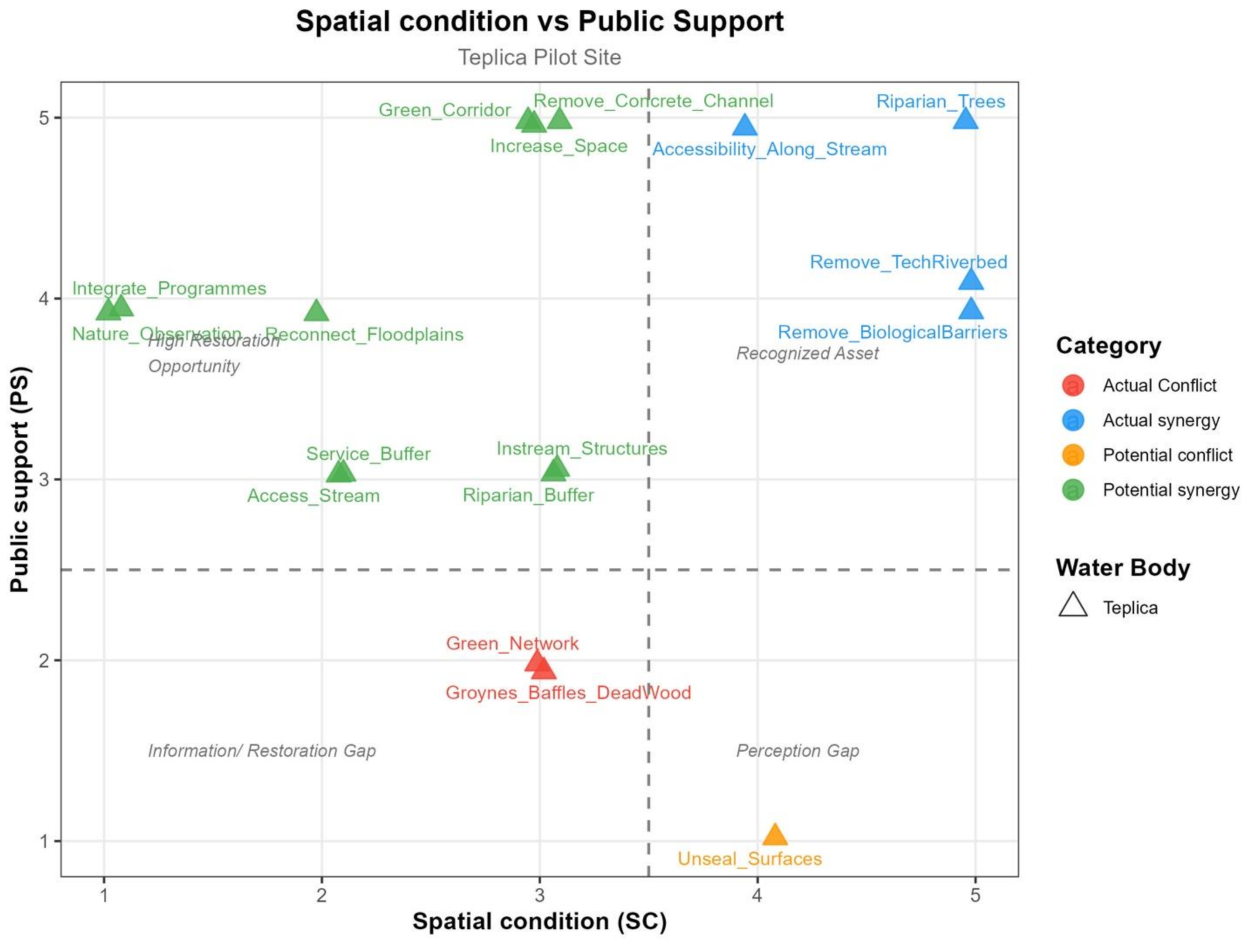

Figure 9. Distribution of spatial condition and public support values for the Teplica pilot stream, shown in a quadrant structure (Acc. to table 2).

Regarding the measure *Integrate programme* (Figure 10), there are only 0 to 2 places that are related to leisure, education, sports around each pilot section, meanwhile this measure is highly supported by the residents. This shows evidence that more related places can be created to increase the multifunctional use of the stream to enhance the synergy among all three perspectives.

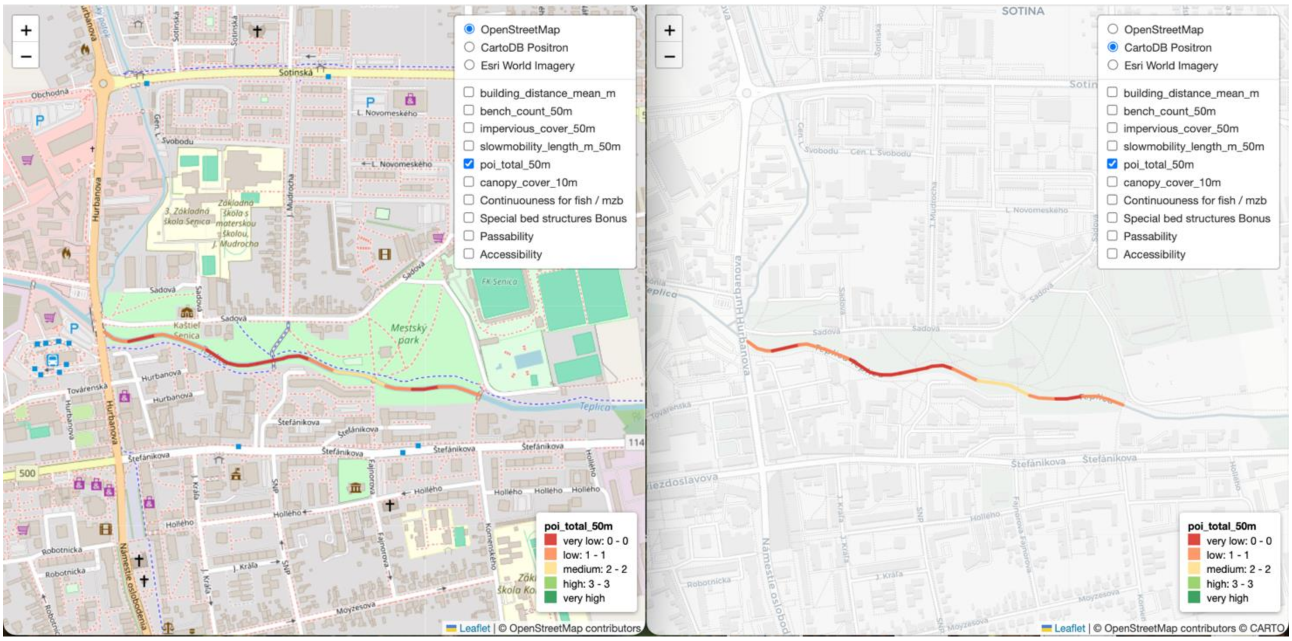

Figure 10 Maps of Teplica showing the values of point of interests (leisure, education, sports) related to integrating programme measure at the 50m section level.

In Senica there is also a potential conflict regarding the measure *Unseal surfaces*, where the impervious condition is good, but not supported by the residents. From a public support-perspective, this is a signal to city officials that, in order to increase acceptance of this measure, it is necessary to raise awareness of its benefits (e.g., improved water infiltration and a potential reduction in flood damage, a contribution to mitigating the urban heat island effect, etc.).

3.6. Comparison of the four pilot sites

When comparing all pilot sites, Bílá Nisa showed the most uniform results (Table 3). For almost all measures, potential synergies emerged, which are in green colour and represent very bad to medium current spatial conditions, but residents would highly support improvements. Only one actual synergy (blue colour, current spatial conditions are good to very good and correspond to the preferences of the residents) and one potential conflict (orange colour, current spatial conditions are good to very good, but people don’t like it) were identified for Bílá Nisa. Of all the pilot sites, Geberbach has the highest number of actual synergies (6, blue) implying that the overall socio-ecological conditions of the pilot site are good to very good and supported by the residents. But there was also one actual conflict (red) for the revitalisation, which means that current spatial conditions are low, and it aligns with preferences of the residents. Similar to Geberbach, Piaśnica pilot site has two actual synergies and also one actual conflict. Teplica is the only pilot site with results in all four categories/quadrants and the highest number of conflicts (3).

Table 3: Synergies and Conflicts result for all analysed restoration measures and pilot sites (indicator values: Public Support (PS)/ Spatial Condition (SC)), measures are sorted in descending order by the sum of all index values

Restoration measure	Measure abbreviation	Bílá Nisa	Geber-bach	Piaśnica	Teplica
Increase space for river and floodplain	Increase_Space	5 / 4	5 / 2	5 / 4	5 / 3
Provide accessibilty along the stream	Accessibility_ Along_Stream	5 / 2	5 / 3	5 / 4	5 / 4
Plant riparian trees	Riparian_Trees	4 / 2	5 / 4	5 / 2	5 / 5
Add transversal green corridor	Green_Corridor	5 / 3	5 / 3	5 / 2	5 / 3
Remove technical riverbed	Remove_ TechRiverbed	5 / 1	5 / 4	5 / 1	4 / 5
Remove concrete channel, Installation of fascines where necessary	Remove_ Concrete_Channel	5 / 1	5 / 4	5 / 1	5 / 3
Plant riparian vegetation (bufferstrips)	Riparian_Buffer	5 / 3	5 / 3	3 / 3	3 / 3
Remove in-stream barriers	Remove_ BiologicalBarriers	3 / 3	4 / 4	3 / 1	4 / 5
Add in-stream structures (dead wood, stones)	Instream_ Structures	4 / 2	4 / 4	4 / 1	3 / 3
Provide access into the stream	Access_Stream	5 / 3	4 / 3	4 / 1	3 / 2
Reconnect floodplains	Reconnect_ Floodplains	4 / 2	4 / 1	5 / 2	4 / 2
Create an interconnected network of green spaces	Green_Network	4 / 3	4 / 3	3 / 2	2 / 3
Enable nature observation	Nature_ Observation	4 / 1	5 / 1	5 / 2	4 / 1
Add groynes, baffles, dead wood and circulation trees	Groynes_Baffles_ DeadWood	3 / 1	3 / 5	3 / 1	2 / 3
Ensure continuous service buffer	Service_Buffer	3 / 2	3 / 2	3 / 2	3 / 2
Integrate programme e.g. leisure, education, swimming	Integrate_ Programmes	4 / 1	4 / 1	3 / 1	4 / 1
Unseal impervious surfaces	Unseal_Surfaces	2 / 4	2 / 1	1 / 1	1 / 4

In total, there were seven measures, namely *Green_Corridor, Riparian_Buffer, Access_Stream, Reconnect_Floodplains, Nature Observation, Service_Buffer, and Integrate_Programmes* that were rated similarly in all four pilot sites (Table 3). All of them are potential synergies (green colour in Table 2). The other ten measures resulted in two or in one case three different quadrants.
Even though seven measures are always in the green quadrant (potential synergy), nearly all showed different values for the indicators assessed. Only one measure: *Ensure continuous service buffer* got the same indicator values for all four pilot sites (PS 3 / SC 2). The measures with the highest public support (PS index 5) over all study sites are *Increase_Space, Accessibility_Along_Stream, Remove_Concrete_Channel,* and *Green_Corridor,* but they have of course different spatial possibilities. Other measures are quite different regarding public perception, especially the measure *Create an interconnected network of green spaces*, which is high valued in Dresden (Geberbach) and Jablonec (Bílá Nisa) (PS = 4), but least in Senica (Teplica) (PS = 2).
In total, 14 of 17 analysed measures resulted in a potential or actual synergy for all four pilot sites. Thus, there were only three measures with potential or actual conflicts in one to four pilot sites. These were *Green_Network, Groynes_Baffles_DeadWood,* and *Unseal_Surfaces*. All three measures caused an actual conflict in one or two pilot sites, which means the current spatial conditions are very bad to medium, but people would not support such kind of improvements. In addition to two actual conflicts in Dresden (Geberbach) and Poznań (Piaśnica), the measure *Unseal_Surfaces* caused two potential conflicts in Jablonec (Bílá Nisa) and Senica (Teplica), making it the measure most prone to conflict of all.
The measure *add groynes, baffles, dead wood and circulation trees* caused the highest variety of analysis results with an actual synergy for Geberbach, two potential synergies for Bílá Nisa and Piaśnica, but an actual conflict for Teplica.
When comparing the numbers of measures classified under each of 4 categories, similarities can be observed between Bílá Nisa and Piaśnica, and between Geberbach and Teplica, as confirmed by cluster analysis.

4. Discussion

4.1. Potential applications

Our method for analysing synergies and conflicts proposed in the ReBioClim project has made it possible to identify the key interdependencies — arising from public expectations and existing spatial conditions — that are crucial for the implementation of restoration measures in urban areas.

This analysis is the next step in a multi-stage process that will contribute to the implementation of the NBS in the restoration of small urban watercourses, thereby improving biodiversity, climate resilience and the quality of life for local residents.

The results obtained are the outcome of collaboration between researchers representing various academic disciplines, including in particular ecologists, hydrobiologists, urban planners, geographers, economists, sociologists, etc., as well as representatives of the cities where the earlier stages of the research were carried out.

It is worth noting that, in addition to the results of surveys and spatial analyses, the study also drew on the outcomes of co-design workshops. Incorporation of results of co-design workshop allowed to filter measures for which were relevant to local experts.

The jointly developed method provides an easy-to-grasp overview of public support and the spatial conditions for proposed ecological restoration measures. However, it should be emphasized that insight into which measures are synergetic and which measures can lead to conflicts with residents still needs further dialogue.

In general, our analysis showed that for all pilot streams, most analysed measures have medium to high public support, which should contribute to strengthening the motivation and chance for urban planners to tackle urban restoration.

The proposed method has been successfully validated using open watercourses as examples, and has also proven effective for the currently underground section of the Piaśnica, where local spatial condition have resulted, on the one hand, in a very low number of ecological measures classified under the 'actual synergy' category and, on the other, in the vast majority being classified under 'potential synergy'.

Classifying individual ecological restoration measures into four categories (actual synergy, potential synergy, potential conflict and actual conflict) facilitates the formulation of recommendations and the development of strategies and action plans for restoring urban streams, which is the next stage of the ReBioClim project.

4.2. Limitations and recommendations for future research

Despite the satisfactory results of the analysis of synergies and conflicts, a number of methodological limitations emerged:

- For 10 out of 27 ecological restoration measures, no data were available from the public survey and/or spatial analysis. These are important measures for both biodiversity, such as *remove wastewater inflow and stormwater run-off*, *fine sediment retention*, and for the quality of life in cities, such as *public spaces facilities*, *provide accessibility towards the stream*, *construct raingarden*, *installation of garbage cans*, *use permeable pavement* or *plant fruit trees/bushes and herbs*. Future studies building on this methodology should aim to achieve higher, better-aligned coverage of restoration measures in the public survey and the spatial analysis.
- For some variables, e.g., *enable nature observation*, we used a single representative spatial variable to indicate the current status associated with each restoration measure, but using more variables can provide a more comprehensive representation of the conditions related to the measure or a better base to choose the most representative variable from.
- We use mean values of all 50-meter stream sections, not site-specific values, because public support data was collected at the level of pilot sites. A more detailed, site-specific understanding of synergies and conflicts would require either a more location-specific survey (e.g., by allowing the respondents to point to the location on a map where their answer applies most) or an approach that disaggregates the survey results to the level of a 50-meter section and provides synergy/conflict results on that level. While this more quantitative approach could yield more detailed results, the mixed-methods approach we took in this report is easier to implement in decision-making processes.
- Some measures are partially overlapping, e.g., *use permeable pavement* and *unseal impervious surfaces*. While the set of ecological restoration measures derived in our project has been validated by experts in the co-design workshops, and we accordingly excluded the least-used measures from our analysis, the set could still benefit from further validation to ensure clarity and avoid overlaps across the set.
- The quality of the value of public support varies across variables because it is based on different types of questionnaire sections. Furthermore, residents' preferences regarding a given measure reflect general support for such measures rather than support for that specific measure in a particular location. Nevertheless, these findings provide urban planners and government officials with clear information about which measures people prefer and, where

necessary, which measures require more communication regarding their benefits for nature and society.

- Some variables were only indirectly included in the structural mapping but could yield direct results if the method is adapted (e.g., *garbage cans*: their presence is a positive factor in the assessment of the “livability of the area”, but they have not been counted).

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