

Regional scalability plan – Case study 11



Emscher basin restoration Emscher-MERLIN vision 2050

Imprint

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Executive summary

1. By 2050, the Emscher catchment will be transformed to a green and blue river landscape. Restoration and water management measures tested in MERLIN will have been upscaled to the entire basin and to neighbouring river catchments.
2. Flowering meadows along rivers and streams / in river basins will have enhanced biodiversity while also brightening the landscape.
3. Citizen science contributes to data generation for drought management and additionally fosters exchange with citizens allowing to educate about the impact of climate change on aquatic ecosystems.
4. These measures, focussing on biodiversity and drought resilience, support additional EU Green deal goals, such as inclusivity, health and wellbeing and circular economy.
5. The Emschergenossenschaft/Lippeverband (EGLV) as large landowner and central water management body in the catchment has an ideal position for coordinating large scale (i.e. catchment wide) and long-term restoration and climate adaptation programs.
6. Thus, there is large potential for the MERLIN measures to be continued and upscaled beyond the MERLIN lifetime.

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1 For the reader

MERLIN enchants the Emscher-region

Emscher-MERLIN vision 2050: How individual measures become a regional strategy

The EmscherGenossenschaft/Lippeverband (EGLV) is Germany's largest water management association, playing a pivotal role in enhancing biodiversity through restoration measures in and around watercourses. EGLV is ideally situated to contribute to blue-green infrastructure in the urbanized Ruhr area of western Germany. The EU research project MERLIN supports and complements EGLV's goals by implementing its own measures, thereby tangibly advancing these objectives. The Emscher-MERLIN Vision 2050 outlines the conceptual framework, objectives, and aspirations emerging from MERLIN's measures, which align closely with EGLV's corporate strategy and future visions, providing a clear pathway for active implementation.

By 2050, the majority of EGLV's green spaces will feature diverse, flowering meadows, thereby boosting biodiversity. Primary beneficiaries will include the flora of species-rich meadows and the insects establishing new habitats near watercourses and on EGLV's land. Attention is required for both larger contiguous dyke areas and smaller, fragmented areas. These fragmented biodiversity zones act as stepping stones, facilitating species movement and supporting EU Green Deal targets. Additionally, the local population will utilize these biodiverse spaces and participate in their conservation, fostering greater environmental awareness. Enhanced landscapes lead to a richer nature experience and higher quality of life, strengthening mental health and serving as a health precaution.

Community involvement is bolstered by initiatives such as Citizen Science, which empowers individuals to take action and feel effective, particularly during crises. By actively recognizing changes in water bodies and the environment, people become more attentive and protective of these resources. Citizen Science observations provide a comprehensive understanding of water bodies, especially those not included in standard monitoring data sets. This contributes to drought management and climate change impact monitoring, where specific focus areas can be identified, and measures initiated to strengthen water balance. Local communities thus become integral to water body maintenance, acting as river keepers.

The inception of the Emscher-MERLIN vision 2050 is predicated upon the two implementation measures of the EU research project MERLIN:

- 1) The establishment of flowering meadows
- 2) The enhancement of citizen participation, which may be conceptualised as a citizen science project

Implementation measures of the EU research project MERLIN

Both implementation measures in MERLIN have the potential to be scaled within and beyond EGLV's catchment area.

The measures include:

- 1) The establishment of flowering meadows: As a large landowner, EGLV is committed not only to increasing biodiversity in streams and rivers but also to enhancing the surrounding terrestrial environment. To counteract biodiversity loss, EGLV aims to improve its grasslands. Extensive grassland maintenance has been shown to boost biodiversity, yet several challenges must be addressed for this conversion. Chief among these is the higher cost of extensive mowing due to the disposal of mowed material. The MERLIN project seeks to identify viable solutions for the utilization of this material and the sustainable management of grasslands. Additionally, MERLIN funds will be used to create new flowering meadows and convert existing grasslands from intensive to extensive maintenance practices.



Figure 1: Example for a biodiverse grassland: Emscher dike in Essen-Karnap

- 2) A cooperation with the citizen science project “CrowdWater”: Everyday observations of water levels become valuable data that complement EGLV’s climate change impact monitoring. This data significantly contributes to drought monitoring efforts. Additionally, the project fosters important exchanges with citizens on environmentally relevant topics, aiming to educate the general public about the impact of climate change on aquatic ecosystems.

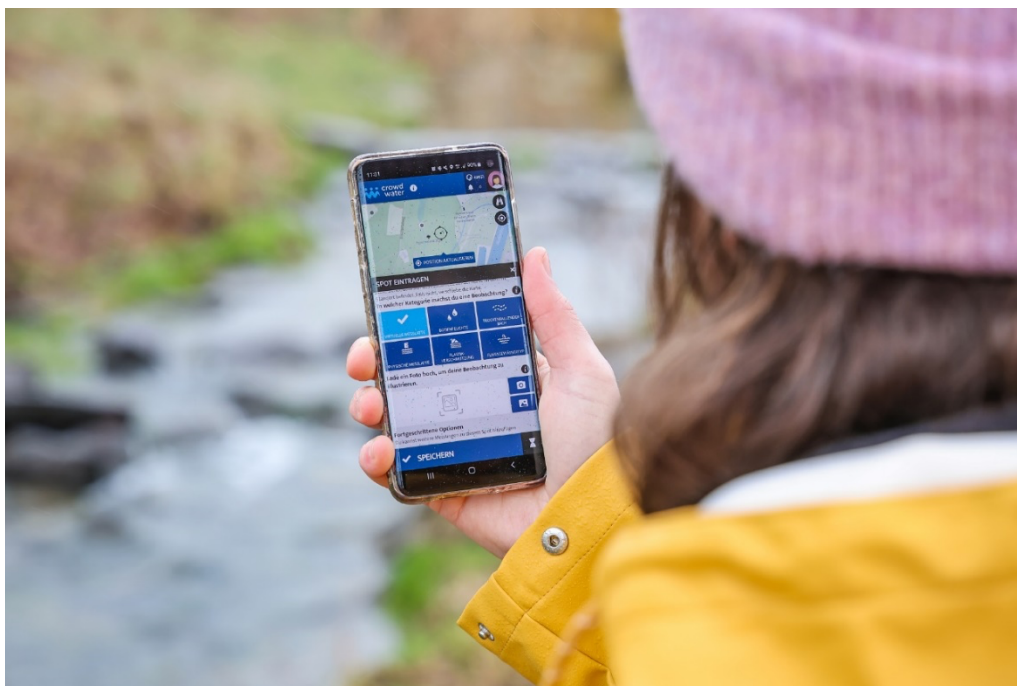


Figure 2: In order to enable citizens to record water levels, a co-operation agreement has been signed with the CrowdWater developers at the University of Zürich.

The two measures selected in the MERLIN project primarily focus on biodiversity conservation and climate change mitigation, particularly in the context of drought management. However, there are numerous other aspects, including health and wellbeing through an enhanced landscape, the circular economy and renewable

energy through the use of grass cuttings. The Citizen Science project engages the population in drought management processes in a participatory manner, raising their awareness and enabling them to take an active role in addressing climate change. This participation can help combat the pervasive sense of powerlessness often associated with this global challenge. The MERLIN measures are a valuable addition to the existing suite of measures for the Emscher conversion, aiming for sustainability and improved quality of life in the region.

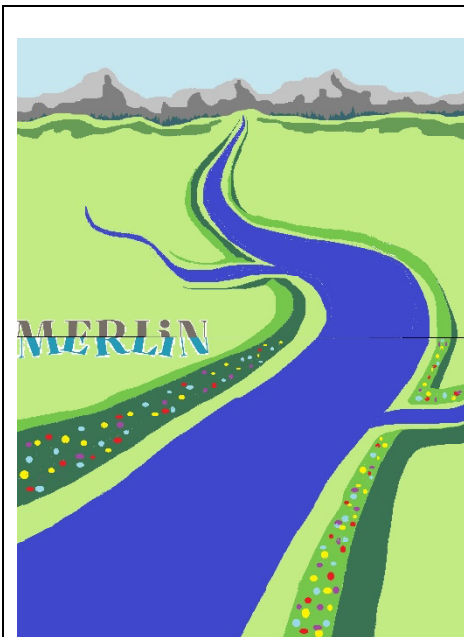


Figure 3: Infographic of the measure flowering meadows

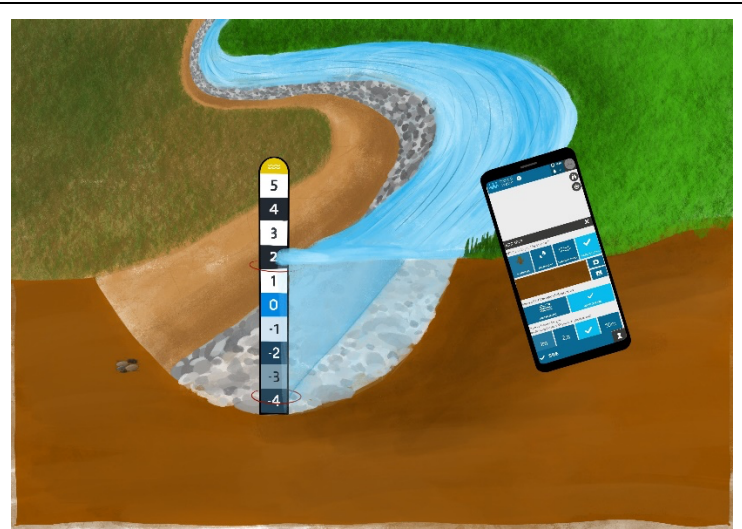


Figure 4: Infographic of the measure citizen science

The incorporation of the MERLIN measures into existing visions from EGLV

The Emscher restoration program itself is already an example of an upscaling process. Initially, stream restoration measures were implemented at pilot sites to gain experience, and gradually, this approach was applied to other streams and sub-catchments. Over time, the Emscher restoration program has expanded to include additional goals such as recreation (e.g., bike paths), environmental education, climate adaptation (e.g., rain-water infiltration), and carbon emission reduction. These goals are outlined in the following strategies, plans, and visions:

- Master plan Emscher future (2006)
- Zukunftsvereinbarung Regenwasser, Future Initiative “Water in the city of tomorrow” and “Klima:Werk” (2005-2021)
- EGLV Horizon 2030 (2015) (Figure 5)
- Teilstrategien (sectoral strategies) until 2050 (2019-21)
- Ecological Hot spot map (2017)
- Krisenhochwasserplan (Flood emergency plan) (2021)
- Dürremanagement-Aktionsplan (drought management action plan) (2022)
- research projects like KliMaWerk:Wasser.Landschaft aiming at drought mitigation (2022-2025)
- River basin management plans according to the European Water Framework Directive (WFD) (since 2000 every 6 years)



Figure 5: EGLV's future vision for 2030, developed in a participatory way as part of the program "Horizon 2030"

Target audience

The **Emscher-MERLIN Vision 2050** is intended for internal use by EGLV employees across various departments, including the operations and maintenance division. At a later stage, it will also involve external stakeholders. The target audience includes:

- ➔ Members of the associations: This includes cities and municipalities, as well as industry and mining representatives.
- ➔ Other landowners: Given that EGLV is a large landowner, this vision can assist other landowners, such as water management boards, cities, and municipalities, in addressing similar issues and implementing biodiversity measures.
- ➔ EGLV divisions: The Regional Scalability Plan (RSP) is designed for EGLV colleagues to adopt and implement the MERLIN measures throughout the entire Emscher and Lippe basin.
- ➔ Other water boards: The RSP can be shared with other water boards to guide the adoption and implementation of the MERLIN measures, climate adaptation strategies, and integration of EU Green Deal goals into water management practices.
- ➔ Government actors: The RSP aims to demonstrate the effectiveness of the MERLIN measures and nature-based solutions (NbS) over conventional solutions and grey infrastructure to government actors.
- ➔ Intended readers and users: This same group is expected to read and utilize the RSP.

Stakeholders involved in RSP development

We maintain a continuous dialogue with NABU (an NGO), Allmende Emscher-Lippe eG (a public-private partnership responsible for the land use on EGLV's properties) and the EGLV biodiversity initiative group regarding the implementation and expansion of the measures. In this RSP, we have also considered the stakeholders' perspective and interests.

The RSP will help/benefit the reader by

- helping to adopt the MERLIN measures throughout the whole Emscher and Lippe basin and also beyond in other river catchments,
- preparing for climate change impacts and implementing climate adaptation measures,
- providing support for monitoring the effects of NbS in order to facilitate the uptake of NbS over grey infrastructure solutions in the future.

2 Focus of the RSP

2.1 Regional characteristics

The 83-kilometre-long Emscher river is a right tributary of the Rhine and flows through the Ruhr area in Germany from Dortmund to Dinslaken. The Ruhr area, with a population of over five million, is the largest metropolitan area in Germany. The catchment area of the Emscher has a population of approximately two million. The Ruhr area is characterised by a high population density, with 1,160 inhabitants per square kilometre. It encompasses several major cities, including Dortmund, Essen and Duisburg. The catchment area of the Emscher, which covers a total of approximately 86,500 hectares (ha), is therefore predominantly urban. The Emscher catchment area is subdivided into three government districts. In each of these districts, the municipalities are responsible for matters pertaining to nature conservation and water resources.

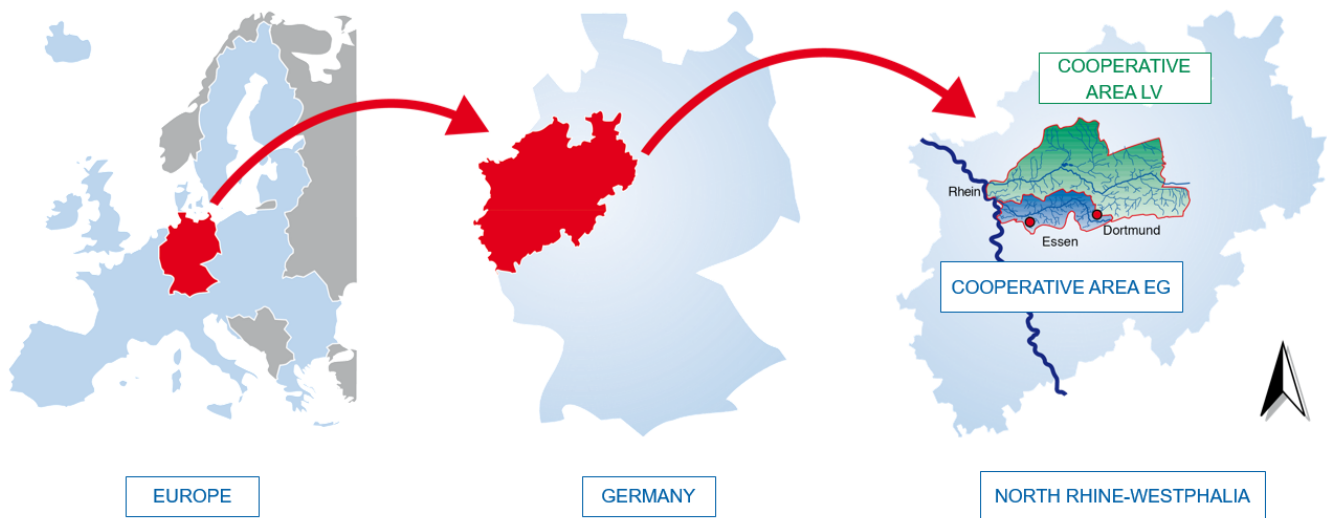


Figure 6: Spatial categorisation of the Emscher and Lippe catchment area

Resulting from the decline of the coal and steel industry in the Ruhr area, a structural change began towards sectors other than coal and steel. However, prominent companies in the coal and steel sectors, such as RAG Aktiengesellschaft, Evonik Industries and ThyssenKrupp, continue to maintain their headquarters and principal production facilities in the Ruhr area and are still important landowners. Currently, the principal economic sectors in the region are the service sector, including the corporate headquarters of energy and water suppliers, the insurance industry and retail groups. Nevertheless, the long history of mining is still reflected in the Emscher river system. Groundwater and stream pumps must be operated to prevent polder areas from becoming flooded. Mine water has been discharged into the river for decades, and numerous contamination hotspots, such as brownfields, are present in the area.

For over a century, the Emscher river and its tributaries have been canalised and transformed into an open sewage system. Soil subsidence caused by underground mining has resulted in the river being surrounded by high dykes, with some parts sinking by up to 30 metres. In some instances, the tributaries are even pumped into the Emscher. Following the completion of underground sewers (400 km), which spanned 30 years of construction, the main sewer that runs 50 km underground parallel to the Emscher river was completed in 2021. This has resulted in the catchment being free of wastewater. Since 1990, numerous tributaries and the Emscher river itself have undergone a process of ecological improvement. One of the most challenging aspects of the project is the lack of space for the river to meander naturally. This is due to the presence of the Rhine-Herne shipping canal and the A42 highway, which run near the Emscher. Nevertheless, the Emscher Masterplan (2006) has delineated restoration and urban development projects within the Emscher basin. The Ecological Hot Spot map (2017) identifies 20 ecological focus points where large-scale renaturation measures of the Emscher main stem are possible through the construction of new floodplains and deltas. The ecological hotspots encompass, for instance, the flood retention basins in Dortmund Mengede and Ellinghausen, Lake Phoenix, and the recently constructed Emscher estuary. Furthermore, additional Ecological Hot Spots are currently under construction or planned.



Figure 7: Visualisation from a grey, canalised sewer system to a blue-green infrastructure with revitalised streams in the Landscape Park in Duisburg

The Emscher genossenschaft, headquartered in Essen, is a legal water management association and a public corporation. Its responsibilities include water maintenance, wastewater drainage and treatment, groundwater management, flood protection, wastewater treatment, and the control of the consequences of mining in the Emscher catchment area (Figure 8).

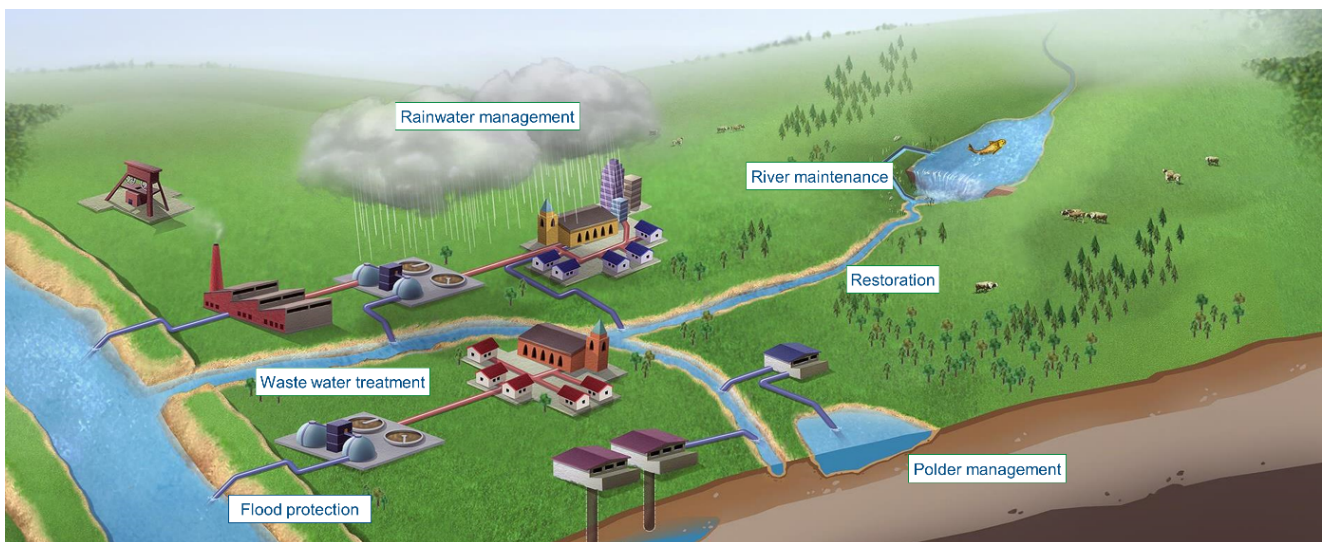


Figure 8: Main tasks of the water management association EGLV

As a water management association, EGLV is confronted with major challenges due to climate change and the resulting increase in extreme weather events. The necessity for more water retention areas arises from changes in runoff conditions, such as heavy rainfall events, while periods of drought cause streams and tributaries to dry out. Efforts are being made to combine and harmonise technical and ecological solutions for sustainable water management, for example, by making flood retention basins ecologically valuable. The flood risk action plan foresees enhanced protection levels for the Emscher main stem. Appropriate management manuals and roadmaps have been created for extreme weather events such as floods (Krisenhochwasserplan 2021) and droughts (Dürremanagement-Aktionsplan 2022) which are now being implemented.



Figure 9: In areas where there is sufficient space, the canalised river can be transformed into a free-flowing Emscher. The Emscher in Oberhausen (left) and the Emscher in Castrop-Rauxel (right) demonstrate the potential of this approach.



Figure 10: Revitalised stream (Borbecker Mühlenbach) as an example for the successful restoration of the smaller tributaries in the Emscher catchment area



Figure 11: The old estuary of the Emscher with a drop structure of 6 meters to the Rhine (left), newly created Emscher estuary with a 20 ha floodplain (right)

2.2 Justification for the region

Due to their conceptual and generally applicable character, the selected MERLIN measures are not restricted to specific locations. Therefore, we considered not only the entire Emscher basin (86,500 ha), but also the Lippe basin which is under the responsibility of EGLV (328,000 ha).

In order to establish the measures for the establishment of flowering meadows and extensive mowing, all maintenance and development plans in the Emscher and Lippe catchment area were analysed, and tenders were checked for intensive or extensive grassland maintenance. A number of areas were identified that have not yet been subjected to extensive mowing. In both catchment areas, EGLV owns 4,300 ha of land. Of these, about 997 ha are grassland managed by the EGLV. The majority of the land is currently managed intensively due to more cost-effective conditions and water management requirements. A rough estimate indicates that approximately 615 hectares could be managed extensively, thereby making a valuable contribution to biodiversity conservation. These areas could function as a green belt throughout the entire Ruhr area.

However, the total potential for upscaling is many times higher, as not only EGLV owns and manages green spaces, but also the cities and municipalities, large landowners and industry in the Ruhr area. The Regional Biodiversity Strategy for the Ruhr Area examines biodiversity in the Ruhr Area from a variety of perspectives and identifies measures for its conservation and promotion. There is considerable scope for most municipalities to align their land use and maintenance policies with the promotion of biodiversity.

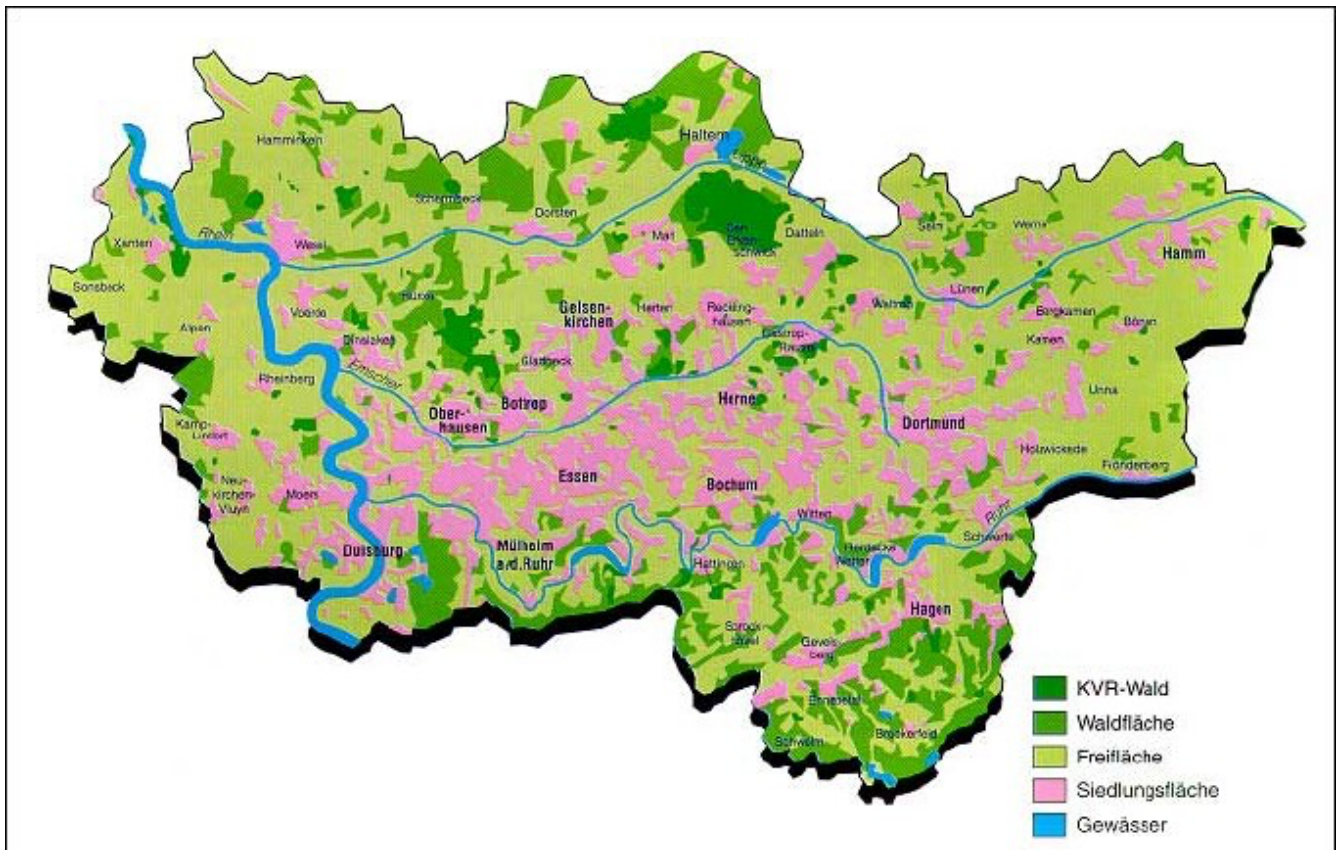


Figure 12: Ruhr Area (443,500 ha); Caption: dark green and green: forest, light green: open area incl. grassland, parks, etc., pink: residential area, blue: water bodies

As part of the Citizen Science project, which aims to collect data on stream water levels, specific areas were selected with particular regard to EGLV's drought management plans. The focus areas are characterised by streams that are temporarily dry, despite their ecological value. These streams have already been the subject of hydrological measurements. In addition, special activities for the general public are to be carried out at those streams, such as guided walks accompanied by practical applications and background information about the streams. Subsequently, the concept is extended to the entire catchment area, commencing with the identified focus areas. It is also important to note that the Citizen Science project is being publicised beyond the focus areas. This is evidenced by the various press releases, radio reports and participatory events that have taken place.

Similarly, the measures can be adopted as blueprint elsewhere, e.g. in other urban river systems. Other water management organisations have expressed a keen interest in the Citizen Science project, with the aim of obtaining more comprehensive data on water bodies. Consequently, the project is well-positioned to be recognised and implemented by other water management associations and cities and municipalities.

Furthermore, the project offers the potential for interaction with authorities such as the State Office for Nature, Environment and Consumer Protection, which is the specialised technical and scientific authority of the state of North Rhine-Westphalia. In addition, cities and municipalities may employ the project and the data collection for their own findings, such as an analysis of how to adapt utilisation practices to mitigate the impact of climate change on local communities.

There is also an interest in linking the Citizen Science (CS) project to other university research projects or initiatives in the Ruhr area.

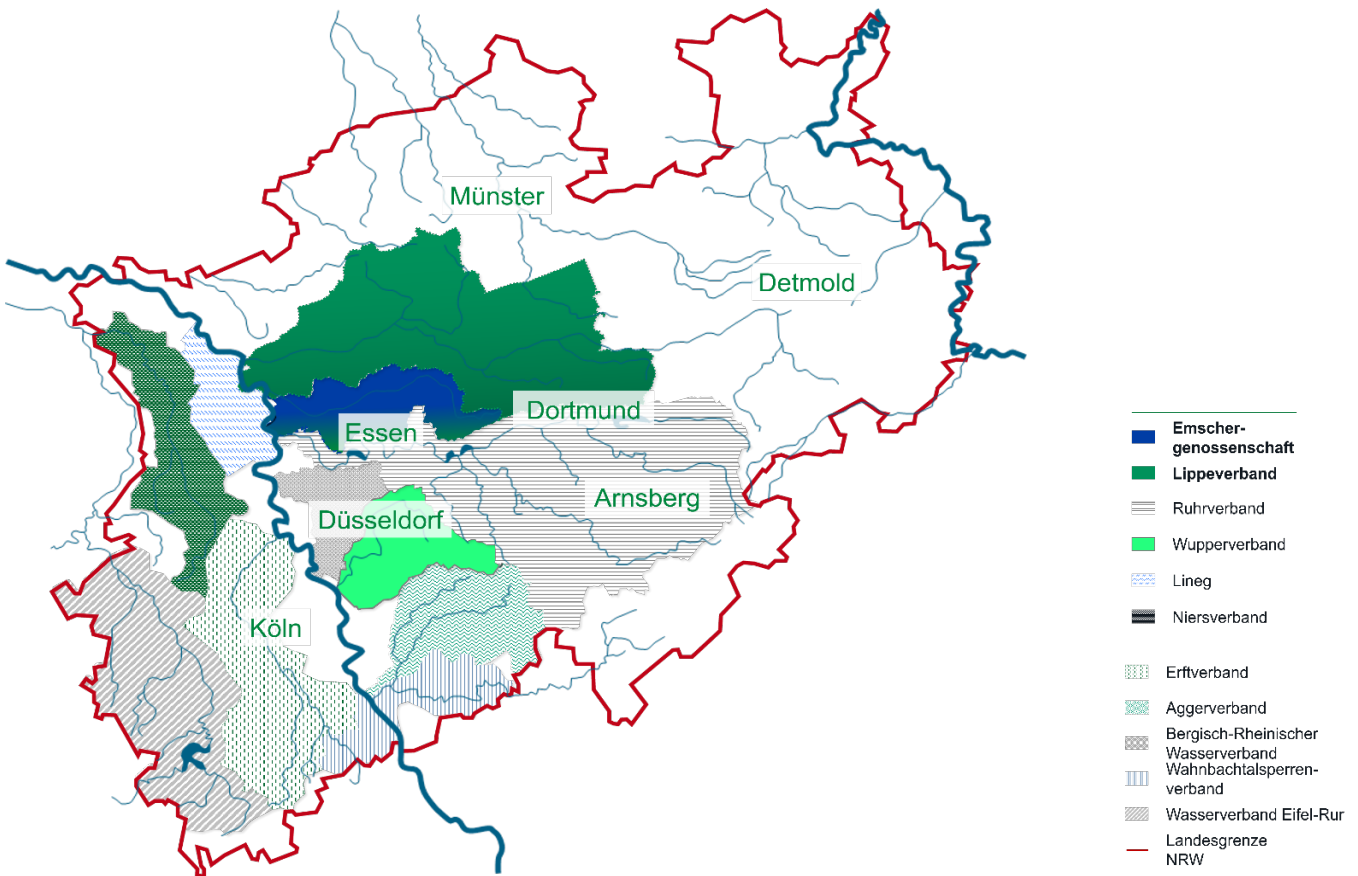


Figure 13: Emschergenossenschaft and Lippeverband and nine more water management association in North Rhine-Westphalia (NRW)

The CS project “CrowdWater” has already a global scope, with over 50,000 observations of water level data on all continents. It can be postulated that participation in the project will increase further, considering the consequences of climate change and the heightened awareness of the importance of water (<https://crowdwater.ch/en/start/>).

2.3 Linkages and synergies with other initiatives

The measures selected in MERLIN and the problems associated with them have been known for some time and have also been recognised nationwide.

The transition to extensive mowing not only affects water management associations but also municipalities and other companies with properties that are to become more biodiverse. A network, entitled "Biodiversity Strategy Ruhrgebiet," facilitates the exchange of information among numerous stakeholders on this topic. The objective of the biodiversity strategy is to formulate regionally harmonised objectives and measures to protect and enhance biodiversity in the Ruhr Metropolis and to provide guidance for future action.

With regard to the citizen science project, which is a collaboration with the existing project CrowdWater, a substantial network of citizen scientists has already been established. Furthermore, the project is part of a forum called "Bürger schaffen Wissen," where experiences with other CS projects are discussed at the annual conference. Other water management associations have expressed a keen interest in collaborating with the CrowdWater project, as they also stand to gain from the hydrological data. Additionally, the EGLV oversees another citizen science initiative, NABU|Naturgucker, which engages citizens in the collection of biodiversity data. The EGLV has established working groups for both projects, which are closely integrated with the marketing and public relations department. In this manner, coordinated concepts are disseminated to multipliers. Furthermore, excursions to the focus areas will be organised in collaboration with nature conservation organisations, local hiking clubs, fishing clubs and canoeing clubs.

No projects or initiatives are in place that may be perceived as opposing or resisting the two implementation ideas.

2.4 Relevant materials

Links to websites:

Homepage EGLV	EGLV - EMSCHERGENOSSENSCHAFT und LIPPE-VERBAND
Biodiversity strategy Ruhrgebiet	Regionale Biodiversitätsstrategie Ruhrgebiet - Netzwerk Urbane Biodiversität (urbane-biodiversitaet.de)
Participation at EGLV	Mach mit! - eglv
Become a stream observer	Werde Bachbeobachter*in - eglv
CrowdWater	CrowdWater
Nabu naturgucker	EGLV (nabu-naturgucker.de)
Plattform „Bürger schaffen Wissen“	Die Plattform für Citizen Science mit:forschen! (mit-forschen.org)
MERLIN optimization strategies (D2.1)	Deliverable D2.1 - MERLIN project (project-merlin.eu)



Figure 14: Flyer and poster for marketing purposes to disseminate the CrowdWater-App

3 Stakeholders of the RSP

3.1 Main stakeholders

The MERLIN implementation measures address different stakeholders. This can enhance participation within EGLV’s work. The existing collaborations through networks, working groups, and interest groups are to be reinforced and expanded. The networks and resulting conferences facilitate the engagement of numerous interested parties, thereby enabling the expansion and scaling-up of the development of the MERLIN measures beyond the EGLV area. In order to achieve this, it is necessary to integrate new players into the existing networks. Furthermore, it would be beneficial to investigate additional avenues for collaboration, such as the recently launched federal and state plans, including the "Action Plan for Nature-Based Climate Protection."

All activities should be conducted in a manner that is mutually beneficial to all parties involved. The following figures present a selection of events conducted within the framework of the MERLIN initiative, which were designed to facilitate networking:



Figure 15: Netzwerk Urbane Biodiversität, Sep 2022

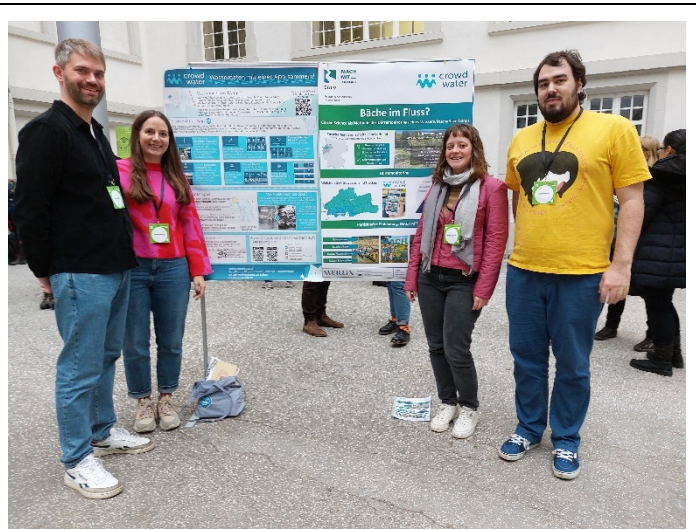


Figure 16: Citizen Science conference, Nov 2023



Figure 17: Conference Society of Ecology, Sep 2023



Figure 18: Biodiversität in der Metropole Ruhr, Nov 2023

Stakeholders for implementation

The primary stakeholders involved in the implementation of flowering meadows are EGLV’s own operations team, the Allmende cooperative, other landowners, towns and municipalities. The regional biodiversity strategy Ruhr Area is being developed by a consortium consisting of the Biological Station Westliches Ruhrgebiet (BSWR), the University of Duisburg-Essen (UDE) and the Ruhr University Bochum (RUB) under the leadership of the RVR.

For a successful implementation of the CS project, it is necessary to roll out a broad participation work and to continuously run this with various actors. Conceivable would be the integration of schools, kindergartens and educational institutions such as NUA (The Nature and Environmental Protection Academy of North Rhine-Westphalia (NRW)) or VHS (Volkshochschule = Community College). Other nature conservation organizations, hiking clubs, fishing and canoeing clubs can also be considered as multipliers.

3.2 Stakeholder mapping

Table 1: Main Stakeholders MERLIN measure: Flowering meadows

Institution	Involvement status	Level of involvement	Scale	Ownership
Operational dept. at EGLV	Already involved	Collaboration	EGLV catchment	public
Allmende Emscher-Lippe eG	Already involved	Cooperation	EGLV catchment and Ruhr area (regional)	public
Regional Biodiversity Strategy Ruhr Area	Already involved	Consultation	regional	Network/community group

Table 2: Main Stakeholders MERLIN measure: Citizen science

Institution	Involvement status	Level of involvement	Scale	Ownership
CrowdWater	Already involved	Cooperation	global	public
NABU	Already involved	Cooperation	regional	NGO
University Duisburg-Essen	Already involved	Collaboration	National/European	public
Forum "Bürger schaffen Wissen"	Already involved	Consultation	national	Community group
VHS Dinslaken	Already involved	Informing	regional	public
NUA: The Nature and Environmental Protection Academy of North Rhine-Westphalia (NRW)	Already involved	Consultation	regional	public

4 Green deal goals

For the MERLIN implementation measures flowering meadows and Citizen Science different main Green deal goals are defined (Figure 19): flowering meadows primarily addresses the Green deal goal biodiversity net gain, while the CS project mainly addresses the Green deal goal drought resilience and inclusive participation.

The establishment of flowering meadows is a direct means of supporting biodiversity. Additionally, the enhanced root coverage could reinforce the stability of the dike, thereby exerting a direct impact on the ecosystem service "flood protection." Furthermore, during periods of drought, biodiverse flowering meadows may exhibit greater resilience to drying out. The increased attractiveness of the flowering meadows also serves local recreational. In addition, the soil can store a greater quantity of carbon. The larger the area transformed, the greater the benefits provided.

The long-term observation of CS data enables the generation of climate change data, which in turn facilitates the development of climate change adaptation plans. EGLV's "Dürremanagement-Aktionsplan" will utilise these data as part of its monitoring activities to support the management of drought (i.e. acute and long-term drought action plans). In addition, the data obtained can be utilised to inform drought communication strategies.

Impact Monitoring

Indicator		Implementation measure			
		Flowering meadows			Citizen Science
		1.1	1.2	1.3	
1	Biodiversity net gain		X*	X*	
2	Climate regulation	x			
3	Flood resilience				(x)
4	Drought resilience		(x)	(x)	x
5	Health and well-being				x
6	Zero pollution				(plastic pollution?)
7	Farm to Fork	x			
8	Sustainable energy	x			
9	Sustainable transport				
10	Inclusive Participation and Governance				x
11	Circular economy	x			
12	Financing the transition	x			
13	Green growth	x			

X* -> PhD Andrea Schneider
Design: Control/impact

Figure 19: Monitoring the Green Deal indicators of the MERLIN measures (implementation site)

A "theory of change" template was developed for the implementation measures in order to illustrate the problems that are to be solved by the measures and the short- medium- and long-term effect the measures are expected to have as well as the linkage to the EU Green deal objectives (Figure 20).

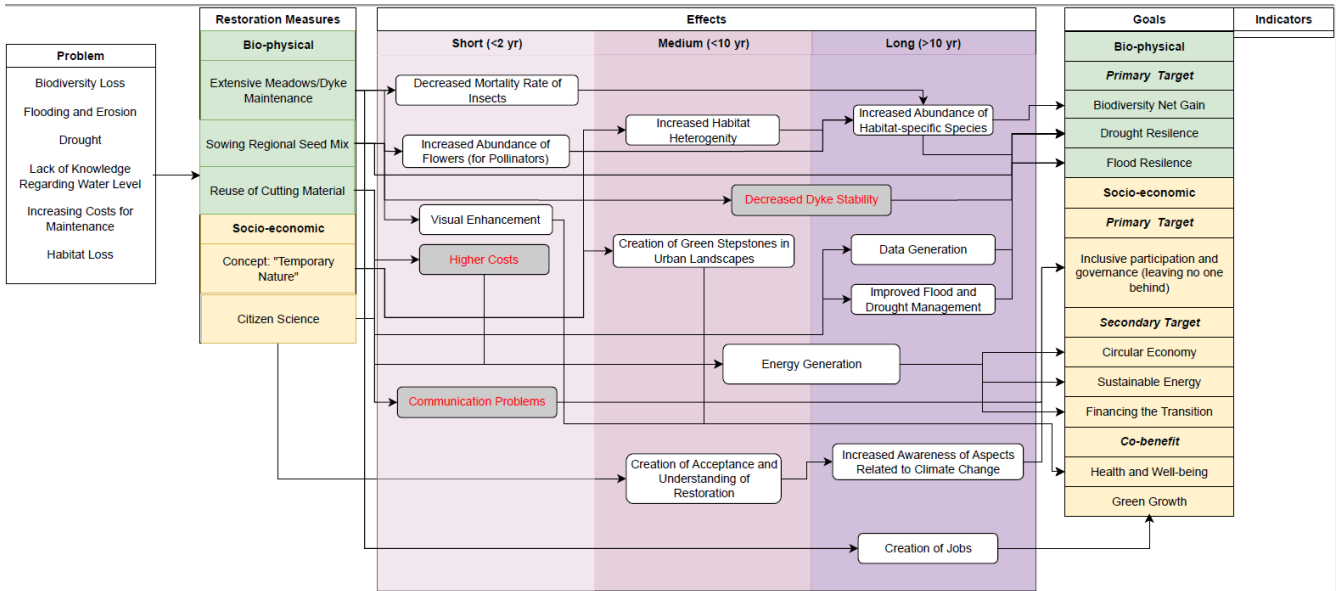


Figure 20: Theory of change for the implementation measures

4.1 SMART Green Deal goals relevant for the region: primary goals

Biodiversity related goals

The implementation measure “flowing meadows” enhances biodiversity. Results of a literature research and the initial results from the monitoring of Andrea Schneider's (UDE) doctoral thesis show that the conversion of maintenance practice of meadows and the sowing of areas with regional seed mixtures leads to a higher variance in species diversity. A higher biodiversity of plant species and pollinators as well as soil insects is expected. Due to the small scale of the MERLIN areas, a change in the conservation status is not to be expected. However, the individual areas can have a positive impact on biodiversity by serving as stepping stone biotopes, especially in such a heavily urbanized area. The size of the area that can potentially be transformed is assessed within MERLIN. By the end of MERLIN, this potential will be clearer, and thus, also its effects on biodiversity.

Measurable indicators:

- Size of the area of newly sown meadows and size of the area of the modified form of maintenance
- Number/increase of terrestrial species

Climate related goals

The use of organic material from meadow mowing as compost, soil fertilizer or biochar in the sense of circular economy offers potential to function as a CO₂ sink. The expected amount of CO₂ stored depends directly on the amount of grass cutting material that can be used as biochar. The amount of material again depends directly on the size of the area that is extensively managed. The storage capacity of CO₂ in the biochar process and its technical feasibility is currently still a research project and therefore cannot yet be precisely quantified. By the end of MERLIN, the potential of this process will be clearer.

Measurable indicators:

- CO₂ balance, CO₂ emissions
- Other greenhouse gas emissions
- Share/increase in renewable energy at EGLV

Inclusivity goals/Goals for local community/public participation

A Citizen Science project represents an excellent example of inclusive participatory citizen involvement. Through the participation of citizens in scientific questions, capacity can be built in addition to the actual data generation. Water level measurement, which is the main aspect of the CrowdWater project, requires the citizen scientists to be in nature at the watercourses and to observe the streams, answering the questions: How does the water volume change after a dry period or a heavy rainfall? The awareness of the effects of climate change on local streams is being raised and knowledge gained. The positive effect of acting on mental health is that it prevents people from feeling powerless in the face of the climate crisis - at least to some extent. Nevertheless, the supervision of a CS project is a time-consuming task. It is necessary to recruit new citizen scientists and disseminate the project. In addition, the participants require a contact person who can assist with queries and support the community. Furthermore, it is beneficial to provide the collected data in a transparent way to the citizen scientists, as CS is a mutually beneficial process. To meet these wishes, in addition to disseminating information about the monitored streams via the app, a range of accompanying initiatives is being developed, including guided tours in collaboration with nature conservation associations.

Measurable indicators:

- Number of users of Citizen science apps Naturgucker and Crowdwater/ number of citizen scientists
- Number of guided tours/ number of participants at events
- Number of website visits at ww.eglv.de

Drought resilience goals

The data collection of the CS project CrowdWater deals with water level measurements. These data can complement EGLV's drought monitoring and provide valuable information on the spatial and temporal resolution of the situation of water bodies during periods of drought and during flooding. The data can be used to identify dry watercourses that were previously unknown. The data can also be used to better understand the biological development of the streams in the catchment and provide possible explanations for fluctuations in water quality.

Measurable indicators:

- Number of observations in Crowdwater
- Number of falling dry streams (and assessing which of these were ecologically restored and which are still anthropogenically modified)

4.2 SMART Green Deal goals relevant for the region: secondary goals

Health and Well-being goal(s)

The establishment of flowering meadows contributes to a transformation of the landscape, rendering it more aesthetically pleasing. The presence of green and flowering meadows is particularly appreciated in urbanised areas. Such environments have been demonstrated to enhance well-being and contribute to mental health.

Participation in a CS project can facilitate the development of self-efficacy. The sense of helplessness often experienced during periods of crises can be alleviated through active participation in such projects. This, in turn, has a positive effect on health.

Sustainable food system/Farm to Fork goal(s)

Cooperation with Allmende, expansion of participatory agriculture in the form of self-sufficiency farming.

Sustainable energy goal(s)

Energetic utilisation of the cutting material from the flowering meadows in biogas plants or sludge co-fermentation in wastewater treatment plants.

Circular economy goal(s)

In order to reduce the higher costs of extensive mowing, it is essential to utilise the mown material. Rather than considering the mown material as waste, it should be regarded as a raw material. The resulting products from the mown material can be reused as energy or material, thereby reducing the costs associated with disposal.

Financing the transition goal(s)

The utilisation of the mown material, whether for energy production or for other purposes such as composting, grass paper or animal feed production, plays an important role in financing the extensive management of the meadows, and thus, the conservation of biodiversity.

Green growth goal(s)

The creation of new jobs is a potential outcome of the large-scale utilisation of mowed material. This could be in the field of energy production or composting.

5 From general goals to actions

5.1 From primary goals to actions

5.1.1 Biodiversity goal

Actions:

- Conversion of standard grassland into flowering meadows through reseedling
- Conversion of intensively maintained grassland into extensive grassland (i.e. two times per year mowing and removing the cutting material)

5.1.2 Climate goal

Actions:

- Test charcoal process using the cutting material obtained from mowing the flowering meadows

5.1.3 Inclusivity goal

Actions:

- Applying the Citizen Science app in the EGLV catchment area
- Events with citizen scientists such as excursions and conferences

5.1.4 Drought resilience goal

Actions:

- Area-wide observations of falling dry streams in the EGLV catchment area
- Good temporal and spatial resolution of water levels of small tributaries and streams

5.2 From secondary goals to actions

5.2.1 Health and Well-being goal

Actions:

- Enhancement of the landscape
- Overcoming bad/helpless feelings of climate crisis through participation

5.2.2 Sustainable food system/Farm to Fork goal

Actions:

- Cooperation with Allmende, expansion of participatory agriculture in the form of self-sufficiency farming

5.2.3 Sustainable energy goal

Actions:

- Energetic utilisation of the cutting material from the flowering meadows in biogas plants or sludge co-fermentation in wastewater treatment plants

5.2.4 Circular economy goal

Actions:

- The reuse of the cutting material from the flowering meadows for either material or energy utilisation

5.2.5 Financing the transition goal

Actions:

- The reuse of the cutting material from the flowering meadows for either material or energy utilisation as a source of income

5.2.6 Green growth goal

Actions:

- The reuse of the cutting material from the flowering meadows for either material or energy utilisation for the creation of new jobs

5.3 The responsible stakeholders and their roles

Table 3: Responsible stakeholders and their roles for the Emscher-MERLIN vision 2050 for the measures flowering meadows and citizen science

	Stakeholder			
	Implement- ation	Funding	Monitoring	Coordination
Flowering meadows				
Conversion of standard grassland into flowering meadows through reseeding	EGLV	EGLV	UDE	EGLV
Conversion of intensively maintained grassland into extensive grassland	Allmende	EGLV	UDE	EGLV
Test charcoal process	Allmende	Allmende		Allmende
Enhancement of the landscape	EGLV	EGLV	-	EGLV
Cooperation with Allmende, expansion of participatory agriculture in the form of self-sufficiency farming	Allmende	Allmende	-	Allmende
The reuse of cutting material from flowering meadows for energetic utilisation in biogas plants or sludge co-fermentation in wastewater treatment plants	EGLV and Allmende	EGLV	EGLV	EGLV
The reuse of the cutting material for material utilisation	Allmende	Allmende	-	Allmende
The reuse of the cutting material for utilisation as a source of income	EGLV and Allmende	-	-	EGLV and Allmende
The reuse of the cutting material for the creation of new jobs	EGLV and Allmende	-	-	EGLV and Allmende
Citizen Science				
Applying the Citizen Science app in the EGLV catchment area	EGLV, NGO, UDE	EGLV	EGLV	EGLV
Events with citizen scientists such as excursions and conferences	EGLV, NGO, VHS	EGLV	EGLV	EGLV
Area-wide observations of falling dry streams in the EGLV catchment area	EGLV and UDE	EGLV	EGLV and UDE	EGLV
Good temporal and spatial resolution of water levels of small tributaries and streams	EGLV and UDE	EGLV	EGLV and UDE	EGLV
Overcoming bad/helpless feelings of climate crisis through participation	EGLV	-	University	EGLV

6 Proposed timeline

All the green deal actions listed above are to be carried out beyond the MERLIN lifetime.

Below, the timeline of the actions are categorized by measure. The actions are listed in the timeline in order of importance, with the restoration of the grass areas with new seed mixtures and the change in maintenance being the most significant. It will take years for these actions to be implemented on a large scale. Milestones in this project will be the solutions for the utilisation of mowed material, which will reduce costs and allow more areas to be redesigned. It is imperative to recognise this “waste” as a potential source of raw material in order to facilitate the generation of finance opportunities and the creation of employment opportunities that extend beyond the scope of the MERLIN project. Over the next 25 years, fossil fuels will continue to decline and be replaced by renewable energies. It is possible that cutting material may be able to make a small contribution to energy generation in the future. Agricultural land could be saved due to the energy crops saved and the mown material could be used in the biogas plant. Further, it can lead to a circular economy in which existing mown material can be reused to produce grass paper or building materials, for example.

Over the next 25 years, the Citizen Science project could be further expanded, thereby increasing its visibility and impact. This would also lead to a significant increase in observations of water bodies and a denser network in terms of time and space with up-to-date or nearly real-time information on water levels. A key milestone would be to identify climate sensitive areas which can then be prioritized with regard to restoration and adaptation measures. Consequently, long-term measures could be implemented to enhance the region’s water balance. Furthermore, the CS project has the potential to raise awareness through participatory involvement about water management and environmental issues, as well as the impact of climate change.

Table 4: Timeline for the Emscher-MERLIN vision 2050 regarding the measures flowering meadows and citizen science

	Period (5-yr interval)				
	2025-2029	2030-2034	2035-2039	2040-2044	2045-2050
Flowering meadows					
Conversion of standard grassland into flowering meadows through reseeding	x	x	x	x	
Conversion of intensively maintained grassland into extensive grassland	x	x	x	x	x
Test charcoal process	x	x			
Enhancement of the landscape	x	x	x	x	x
Cooperation with Allmende, expansion of participatory agriculture in the form of self-sufficiency farming	x	x	x	x	x
The reuse of cutting material from flowering meadows for energetic utilisation in biogas plants or sludge co-fermentation in wastewater treatment plants	x	x	x	x	x
The reuse of the cutting material for material utilisation	x	x	x	x	x
The reuse of the cutting material for utilisation as a source of income	x	x			

	Period (5-yr interval)				
	2025-2029	2030-2034	2035-2039	2040-2044	2045-2050
The reuse of the cutting material for the creation of new jobs	x	x			
Citizen Science					
Applying the Citizen Science app in the EGLV catchment area	x	x	x		
Events with citizen scientists such as excursions and conferences	x		x		x
Area-wide observations of falling dry streams in the EGLV catchment area	x	x	x	x	x
Good temporal and spatial resolution of water levels of small tributaries and streams		x	x	x	x
Overcoming bad/helpless feelings of climate crisis through participation	x	x	x	x	x

7 Opportunities for financial implementation

As a self-governing body operating under public law, EmscherGenossenschaft/Lippeverband is supported and financed by its members, comprising cities, industry and mining. The members participate in the formation of opinions and the making of decisions through the annual assemblies and the association councils.

The maintenance of grassland is financed by EGLV. The additional costs for extensive mowing represent a central question in the economic feasibility study conducted as part of the EU research project MERLIN. The projected increase in costs for converting grassland of EGLV's land property from intensive to extensive maintenance is estimated to be approximately 1.5 million euros. Should solutions for the utilisation of the mown material be identified within MERLIN, these costs can potentially be reduced considerably or full cost-efficiency achieved.

As part of the upscaling of the Citizen Science project, the costs are low because the strategic investments into app development and IT support have already been made. Nevertheless, it is of importance that social events for the scientists are organized in order to encourage participation in the long-term. Nevertheless, the costs associated with events and personnel expenses can be offset by the internal positions at EGLV dedicated to the development of sustainable education.

8 Uncertainties and assumptions/boundary conditions

This RSP is written under the assumption that the current organization and financing structure of EGLV will be continued throughout the next decades. Uncertain is the development of means of financing under climate change and social instability scenarios. Priorities could shift and budget would, consequently, be used for other purposes. Similarly, this plan is based on current legislation and policies, including political aims like the EU Biodiversity strategy and Green deal goals, assuming these will be maintained in the future.

As EGLV is in large-parts the responsible body for coordinating restoration and climate adaptation measures and monitoring activities, we have a relatively high control over implementation in the catchment.

The transformation of intensively to extensively managed meadows in the Emscher could be hindered by conflicts for land use. Enough land needs to be secured and/or swapped for restoration action. There is also the risk that the mowing material cannot be utilized in an economically efficient way, making extensive management an economically unviable task. However, the more the area is transformed, the more benefits there will be and synergies in management will reduce the personnel and financial effort. These risks can be mitigated by highlighting the benefits of flowering meadows and showing monitoring results and positive images, narrative and factors of success learned during the MERLIN project.

The continuation of the Citizen Science project comes along with a low risk. The increased occurrence of floods and droughts, as predicted under climate scenarios, will lead to increased willingness to act against floods and droughts via grey as well as nature-based adaptation measures along with monitoring and management efforts.

As further factors for facing risks and enhancing the chance of transforming the region we plan to:

- identify priority areas and monitoring and communicating the success and generated benefits,
- offer field-visits to successful restoration sites,
- provide guidelines for single measures and a toolkit of measures that is widely applicable in the entire region,
- continue to build alliances with our stakeholder groups.