The CLAIRO Project Journal N°3

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In the past 12 months CLAIRO project has entered its final phase with key project outputs starting to materialize. This third edition of CLAIRO Journal outlines progress under CLAIRO and the key challenges tackled by the partnership along the journey, or which are yet to be tackled during the project final year and beyond.

Executive summary

As one of the most relevant acts of CLAIRO, an area of over 20,000 m² in total was planted with greenery in Ostrava in 2021 from mid-March to early May. Altogether 442 new trees and 1867 shrubs were planted and almost 15,000 m2 of lawn was installed in the two target areas of the project, which are located in the Radvanice and Bartovice neighbourhoods of the city. This green infrastructure intervention is meant to function as a testbed, a living vegetation lab encouraging the smart use of nature-based solutions aiming at air quality improvements in urban areas elsewhere in the Moravian-Silesian Region and in Europe.

Following planting, as part of an innovative method, the soil and the plants were treated with specific preparations that contain plant hormones and biostimulants. It is expected that the innovative treatment will increase the resistance of the greenery to various environmental stressors and will enhance its ability to capture air pollutants.

The lessons of the project activities are summarized in one of the main outputs of the project, a Methodology paper on 'Green infrastructure and its impact on air quality'. The publication is targeted at professionals, air quality and urban green infrastructure experts and the research community.

A Manual that is a shortened version of the Methodology was also published to reach out to non-specialist audiences. These two documents are meant to lend a hand to cities for designing similar green infrastructure interventions and for tracking their effectiveness.

Specific models were developed by the CLAIRO team, to allow accurate quantification of the positive effects of greenery on air quality, as well as the prediction of future capture by the vegetation and through this the assessment of the viability of the tested methodology.

One of the main objectives of CLAIRO is to demonstrate the positive impact of urban greenery on air quality and to disseminate the comprehensive methodology developed under the project across Czech Republic and Europe. A robust and concentrated outreach campaign is undertaken by the partnership of CLAIRO to create a platform of trained experts and students, informed cities and partner companies so that they can benefit from the shared

knowledge gained from the living lab. As part of the outreach activities, key actors have been engaged in a series of public events, that range from a national conference, through training events, information workshops, and webinars to consultations.

The findings of two public opinion surveys on air quality, which were conducted in 2019 and 2020, were evaluated in a study on behavioural changes linked to air quality and urban greenery. The paper highlighted that a remarkably high proportion of the population of the Moravian-Silesian Region considered the topic of air quality to be important. Suggesting the relevance of the CLAIRO project, over three quarters of the survey respondents supported the application of nature-based solutions in urban areas.

The pandemic has revealed the importance of urban green spaces, as places enabling social interaction and outdoor activities amid social distancing measures. In addition, the Covid-19 crisis amid reductions in emissions of air pollutants drew attention to the relevance of urban air quality. The pandemic has also made people more concerned about their health. All these developments have led to a renewed support for CLAIRO. The key findings of the study published under CLAIRO has further reinforced political buy-in for the project.

Transferring the knowledge accumulated and scaling up project results remains a critical challenge in CLAIRO. Originally a massive number of events were planned to support the replication and roll-out of the CLAIRO approach across the Moravian-Silesian Region and beyond. Due to the impacts of Covid-19, the vast majority of these events have been postponed or had to be held virtually. In general, despite all the difficulties posed by the pandemic, the trainings, workshops, seminars proved to be effective tools for transferring project results to key stakeholder groups.

Key activities and interim results

Planting and treatment of new greenery

As one of the most relevant acts of CLAIRO, an area of over 20,000 m² in total have been planted with greenery in Ostrava in 2021 from mid-March to early May. Altogether 442 new trees and 1867 shrubs have been planted and almost 15,000 m2 of lawn have been installed in the two target areas of the project located in the Radvanice and Bartovice neighbourhoods of the city.

New greenery in Bartovice

The design of the composition and structure of the greenery at the two plots was supported by a model of capture of air pollutants, which was developed based on measurements of air pollutants and climatic conditions.

This green infrastructure intervention is meant to function as a testbed, a living vegetation lab encouraging the smart use of nature-based solutions aiming at air quality improvements in urban areas elsewhere in the Moravian-Silesian Region and in Europe.

The selection of the target sites was carefully planned to be able to effectively demonstrate the capture of air pollutants. A number of factors were considered during the selection process. First of all, plots located in the most polluted areas of Ostrava were sought in the direct vicinity of a metallurgical plant operated by Liberty Ostrava. The prevailing wind direction was also taken into account, the plots being east of the facility in the downwind side of the smelting plant, so that the pollution plume usually moves towards the plots. It was also an important consideration to pick locations with different soil types that favour differing plant species.

A multi-level plant cover was created to filter as much as possible the quantity of air pollutants. Species with large mature size, high canopy density and well-developed crowns were used. An additional vegetation layer was provided by shrubs.

A specific treatment method developed by the Palacky University Olomouc have been applied on the newly planted greenery. The soil and the plants have been treated with specific preparations that contain plant hormones and biostimulants.

The vegetation at the two target sites is exposed to multiple abiotic stressors such as poor air quality, soils lacking nutrients or heavy metal contamination. It is expected that the innovative treatment will increase the resistance of the greenery to these stressors. It is also foreseen that the health of plants will improve in general, trees and shrubs growing denser foliage, resulting in longevity. All these positive changes will enhance the ability of the new greenery to capture air pollutants.

The first treatment took place following the planting of the trees in June, and the second one in September 2021. The physiological effects of the preparations are monitored regularly by the Palacky University by measuring photosynthetic parameters and gas exchange characteristics of the plants.

Monitoring the physiological effects of the innovative treatment on plants

Methodology paper and Manual: blueprints for cities

The lessons of the project activities are summarized in one of the main outputs of the project, a Methodology paper on 'Green infrastructure and its impact on air quality'. The guidance document aiming to support effectively the replication of innovative solutions tested under CLAIRO, was produced as the result of a collaboration of three universities, the Silesian University in Opava, the Technical University of Ostrava, and the Palacky University Olomouc. The publication is targeted at professionals, air quality and urban green infrastructure experts and the research community. The document outlines the principles of planting new greenery for air quality improvements, explains why air quality monitoring is necessary and how it is performed. It provides information

on the relevance of modelling pollutant capture by the vegetation and on how it can be undertaken. It also addresses data management, as well as the innovative treatment of the plants.

A Manual that is a shortened version of the Methodology was also published to reach out to non-specialist audiences. These two documents are meant to lend a hand to cities for designing similar green infrastructure interventions and for tracking their effectiveness.

The Methodology and the Manual were made public in Czech language in spring 2021. The English versions were published at the end of January 2022.

The basic principles for planting greenery for pollutant capture showcased by the Methodology and in less detail by the Manual can help cities embarking on using nature-based solutions to improve urban air quality.

Major events provide visibility for CLAIRO

On 29 June 2021 an online National Conference on 'Growing Greenery in the City' was held under the CLAIRO project, promoting its innovative aspects and outputs. The conference embedded into a broader context the topics addressed by CLAIRO. The event covered several specific themes linked to nature-based solutions, urban planning, health and wellbeing, such as the trends of air pollution, the health impacts of pollution exposure, the use of blue-green infrastructure for water retention, and the design of high-quality green spaces. Nearly 100 participants were attracted to the event from around 30 cities from Czech Republic.

During the event an overview was provided of the situation of air quality in the Moravian-Silesian Region, and of how human perception of air quality influences the application of effective mitigation measures. The benefits of various types of blue-green infrastructures, such as green roofs, green tram tracks, bioswales along sidewalks, flower beds, or forest parks were addressed, as well as their role in developing a sustainable and healthy city. Specific attention was devoted to the vital role of blue-green systems in retaining rainwater, and to the specific elements of green infrastructures that can help in this regard, such as climate parks, cloudburst streets, green retention streets and green parking.

Hints were also shared on what makes a good green space, and how to create better parks. It was stressed that the key for a pedestrian city is not the total area of green spaces but compact neighbourhoods with larger buildings of various functions surrounded by a diversity of strategically located smaller green spaces. It was highlighted that paradoxically a city where everyone lives in the green is actually a city where everyone has to drive anywhere.

To reach out to the international professional community, an online CLAIRO International Conference on 'Livable and climate resilient European cities' was organized on 22 March 2022 by the City of Ostrava. The event was meant to help rolling out the CLAIRO approach across European cities. Although the spotlight was on the functions of greenery in urban landscapes and its impact on air quality, other related themes, such as the use of nature-based solutions to mitigate heat stress and to develop resilient cityscapes, planning a 30-minutes city, or the role of green spaces in delivering positive health outcomes were also covered.

Measurements and modelling

The project team have continued air quality measurements by the 20 sensor units that had been deployed at the target areas in Ostrava. The measurements are relevant for tracking improvements related to air quality over a longer time-period and for assessing the effectiveness of the planted greenery in filtering pollutants. Air quality monitoring is also undertaken in six other neighbouring cities in the Ostrava- Karvina Industrial Agglomeration to support additional green infrastructure interventions across the region. In the latest project period measurements were carried out in Frýdek-Mistek and Karviná, and in a next round in Rychvald and Havirov.

Specific models were developed by the CLAIRO team to allow accurate quantification of the positive effects of greenery on air quality. The full potential of the newly planted greenery in terms of filtration of pollutants will be realized only decades following project closure. Therefore, modelling is vital for predicting future capture by the vegetation and through this to assess the viability of the tested methodology.

A series of different overlapping models were developed by the Silesian University in Opava under the project. The first one enabled the quantification of air pollutant captured by the original greenery. The second one was linked to the capture-by-design greenery, while the third one developed in summer 2021 helps assessing pollutant removal by the newly planted greenery. A fourth model developed at the end of 2021 allows predictions of the future capture. By February 2022, these separate models were integrated under a complex composite model of dispersion, deposition, capture and resuspension of pollutants. With the help of the models, it can be tracked how pollutant capture is changing at the target sites as the total leaf area is increasing over time. Using the models, cities aiming to apply the CLAIRO approach can determine the area of an urban forest that can effectively mitigate exposure to air pollutants.

A database of plant species to support cities in cutting back pollution exposure

An online database of plants suitable for mitigation of air pollution has been available since February 2022. The database includes a number of relevant parameters, such as climatic requirements, sensitivity to acid deposition and to ozone and the ability to remove particulate matter. This tool is meant to help local authorities when selecting the most suitable plant species for green infrastructure interventions targeting reduction of exposure to air pollution.

Latin name	Georelief	Climate	Acid rain tolerance	Ozone tolerance	Removal efficiency
Pinus nigra	mountain	subtropic	resistante	tolerant	high
Picea abies	mountain	boreal	sensitive	resistante	medium
Abies alba	upland	temperate	tolerant	resistante	medium
Quercus robur	lowland	temperate	resistante	resistante	medium
Quercus petraea	lowland	temperate	resistante	resistante	high
Malus sylvestris	lowland	temperate	resistante	resistante	medium
Ulmus minor	lowland	Mediterranean	tolerant	tolerant	high
Cornus sanguinea	lowland	temperate	tolerant	resistante	medium

Database of plants

A study confirms significant concerns about air quality

The findings of two public opinion surveys on air quality, which were conducted in 2019 and 2020, were evaluated in a study on behavioural changes linked to air quality and urban greenery. The study was published in September 2021. The study addressed three distinct themes, air quality, urban greenery, and the willingness of people to change their behaviour to improve air quality. The paper highlighted that a remarkably high proportion of the population of the Moravian-Silesian Region considered the topic of air quality to be important, and that the majority of people living in the region take an active interest in this theme. On the other hand, perceived satisfaction with air quality was found to be relatively low in the region. Over three quarters of the survey respondents supported the application of nature-based solutions in urban areas, suggesting the relevance of the CLAIRO project.

Challenges for implementation

The implementation of a project, which applies and disseminates a comprehensive methodology maximizing the positive impact of urban greenery on air quality, and which exploits innovative solutions, has led to a number of challenges that have to be dealt with. Various risks and challenges that are faced by the City of Ostrava during the implementation of the project are outlined below.

Leadership

Ever since the pandemic has started, greenspaces in cities were getting a lot more attention from residents, urban practitioners and decision-makers than usual. Availability of green spaces took on a whole new importance. Additionally, the Covid-19 crisis has awoken the world to the importance of air quality, as early in the coronavirus pandemic, concentrations of air pollutants dropped significantly. Experience also indicates that people became significantly more health-conscious since the emergence of the coronavirus crisis. Due to all these developments Tomas Macura, the mayor of the City of Ostrava has provided increased political support to the activities of CLAIRO.

The key findings of the study published by SOBIC under CLAIRO, (i.e., that the vast majority of the population of the Moravian-Silesian Region consider the topic of air quality to be important, and also support the development of new forms of greenery in urban areas) has further reinforced political buy in for the project.

Due to the difficulties brought by the pandemic, meetings of the core project team members of the city administration were held virtually in certain periods, but they continued to be organized on a regular basis.

Public procurement

Public procurement procedures under CLAIRO were linked to the purchase of the measurement equipment, laboratory equipment, and new greenery. Due to careful preparation, no major procurement issues were linked to these procedures.

Organisational arrangements within the urban authority

Due to the interdisciplinary nature of CLAIRO a number of departments work together in the City of Ostrava on project implementation. The Strategic Development Department, which is responsible for coordination, is closely collaborating with the Department of Environmental Affairs, the Department of Public Procurement and the Financial Department.

The core project team has found flexible ways to adapt to the impacts of the subsequent waves of the coronavirus pandemic. Depending on the actual situation cross-departmental meetings were held as either physical or virtual events, but attention was paid to their regular occurrence so as to maintain the enthusiasm for CLAIRO across the various units. Communication with people well in advance was a key factor in handling issues and enabling smooth management. Being aware of the difficulties linked to the pandemic and sensing the urgency of the situation, the city administration provided useful IT support to the core project team. Luckily, during restrictions linked to the Covid-19 crisis, the activities were mainly linked to greenery planting, which were barely affected by the pandemic.

Participative approach for co-implementation

There are certain challenges associated with making the collaborative system of CLAIRO work by ensuring the full participation of all project partners and external stakeholders. Effective collaboration among project partners is ensured by a large number of project partner meetings and smaller thematic group meetings. Because of COVID-19 most of these had to be organized virtually. Although partners attended a physical project partner meeting only once after a long time, on 5 October 2021, still the consortium has found a way to work together effectively.

Apart from project partners, a great number of external stakeholders are involved actively in the activities of CLAIRO. The pandemic necessitated a review of the planning of the various public events.

Monitoring and evaluation

Since one of the specific objectives of CLAIRO is to verify the impacts of greenery on the reduction of air pollutants, monitoring has a vital role in the project. The monitoring activity is connected to two distinct areas of project implementation.

In the first place, continuous measurements of air pollution and meteorological parameters are performed by the Technical University of Ostrava under the project. Air quality monitoring has been essential for supporting the design of the new greenery, for the development of models of pollution capture by urban vegetation, and also for tracking development relating to air quality improvements over a longer time period and through this for assessing the filtration efficiency of the greenery. Secondly, the Palacky University Olomouc has been regularly monitoring the physiological effects of the innovative treatment on plants.

Some of the most crucial challenges in CLAIRO are associated with the monitoring activity linked to both air quality measurements and the effects of plant treatments.

In winter 2021-2022, following the plantation of the new greenery, the air quality in Radvanice and Bartovice was poorer than during the two previous winters. This can be attributed to unfavourable dispersion conditions and the positive influence of Covid-19 lockdowns in the previous winter seasons. Because of this negative change in pollutant concentrations, it is estimated that no major change will be seen in filtration efficiency when measurement results will be made available at the end of April 2022.

As measurements will be performed for several years after project closure, it is expected that in the long-term the positive impact of greenery on air quality will be verified. Such a positive trend is also supported by modelling results. In addition, to correct deviations in annual air quality concentrations, the Technical University of Ostrava will compare the data measured from 2019 onwards with standard air quality data from the previous couple of years accessed from the stations of the Czech Hydrometeorological Institute.

Regarding the monitoring of the effects of the innovative treatment, following the first application, both control plants and those that had been treated with specific preparations were found to be in good physiological conditions, making hard the verification of the method's effectivity. The fact that control plants are in good

condition also indicates that the right species were selected, and well-functioning ecosystems were designed by the Silesian University in Opava. Long-term monitoring will be key in this case, as over time, because of the unfavourable environmental conditions on target sites, differences in plant health are expected to emerge depending on the type of the treatment.

Communication with target beneficiaries and users

Why air quality monitoring is necessary? How is the monitoring activity undertaken? How can data management help? Why modelling of pollutant captured by the vegetation is relevant and how it is done? Why greenery meant to capture air pollutants is treated by plant hormones and biostimulants? These are questions linked to the key components and activities of CLAIRO. Due to the technical aspects of the project, it is hard to create an effective narrative for city representatives about CLAIRO that offers easy-to-understand explanations to these questions.

To overcome this communication difficulty, the CLAIRO partnership in its final dissemination efforts should simplify as much as possible the key messages of the project targeting decision-makers, urban practitioners and the general public.

Due to the impacts of the pandemic, communication with target beneficiaries and other stakeholders required a different approach compared to the original plans. A much shorter time was available for the organization of larger public events and smaller-scale public seminars. Many of these events had to be organized virtually, and their format and structure had to be adapted to the new circumstances.

Upscaling

Transferring the knowledge accumulated and scaling up project results remains a critical challenge in CLAIRO. Originally a massive number of events were planned to support the replication and roll-out of the CLAIRO approach across the Moravian-Silesian Region and beyond. These events include trainings, workshops for cities, or public seminars. However, on account of Covid-19 the organization of these events were not without difficulties.

To allow physical attendance the vast majority of these events had to be postponed until autumn 2021, and even after rescheduling a large number of them had to be held virtually. Originally 16 public seminars were planned to target mostly secondary schools. In the end altogether 19 seminars were held, and only two of these were held as physical events, the rest being organized as webinars. In general, the experience with the webinars was positive, the organizers managed to maintain the quality of these events and participants confirmed that the topic was important for them.

Despite all the difficulties posed by the pandemic, the trainings, workshops, seminars proved to be effective tools for transferring project results to key stakeholder groups.

Apart from the various types of public events, the Methodology paper, the Manual, the online database of plants suitable for mitigating air pollution, and the integrated model of pollution capture will support both scaling up the activities in the City of Ostrava and rolling them out in the Upper Silesian metropolitan area and across Europe.

There are already some concrete results due to the efforts targeting at replication. Apart from Ostrava, air quality measurements have also been performed in six pilot cities in the Ostrava-Karvina Industrial Agglomeration to support additional green infrastructure interventions across the region. Třinec, one of the six cities, following a decision of the city council, has already indicated its intention to incorporate the implementation of the innovative approach of CLAIRO in the strategic plan of the municipality. The city of Orlová, which is not among the six pilot cites, also became interested in the project results, and similarly to Třinec, their city council plans to integrate the CLAIRO approach in their updated strategic plan.

There are also developments in Ostrava that suggest that project results will be upscaled within the city. The company responsible for the maintenance of urban greenery in the City of Ostrava is interested to apply on unhealthy trees the innovative soil and plant treatment tested by CLAIRO. The district-level greenery maintenance company, whose activities are covering Radvanice and Bartovice neighbourhoods, is similarly interested in applying the innovative soil and plant treatment method.

Lessons learnt and conclusion

The project has seen an extremely dense period from autumn 2021 in terms of outreach activity. The rich diversity of public events targeting various actors will increase the likelihood of replication in the Moravian-Silesian Region and across EU member states.

The intermediate monitoring results linked both to the concentration of air pollutants and to the physiological state of plants following the innovative treatment confirm the relevance of long-term monitoring and modelling. Over years the canopy of the newly planted trees will be more extensive leading to gradually increasing filtration capacities. Similarly, in the absence of the innovative treatment of plants, the various environmental stressors may significantly worsen the physiological condition of the plants over the years, as compared to treated vegetation. Project partners undertook to continue air quality measurements and the monitoring of plant health for several years after the project was completed. The fact that the monitoring activity had been foreseen for a longer period after project duration, shows that consortium members acted prudently during project planning. Apart from long-term monitoring, the role of modelling is vital, as it enables the prediction of the magnitude of pollutant capture for the upcoming decades.

Simple communication is key for effective roll-out of the solutions of a complex project, such as CLAIRO. Although for the professional community the details of air quality monitoring, data management, or modelling can be relevant, city representatives will be interested in more practical aspects. For them it is less relevant how the applicability of the project-based solutions was verified. The main message for them should be centred around the health impacts of air pollution, the benefits of using greenery for air quality improvements, key design considerations, and the innovative treatment of plants.

The project partnership is looking forward to a busy final period within CLAIRO. By March 2022 the online database of plants suitable for mitigation of air pollution will be made accessible on the website of CLAIRO. Similarly, by March the separate models developed by the project consortium will be integrated into a single composite model of pollution capture that can help other cities in designing greenery for reduced pollution exposure. As a major dissemination event, an online CLAIRO International Conference was organized on 22 March 2022 by the City of Ostrava to summarize the key achievements of the project and to promote to cities the use of nature-based solutions in an urban setting.

Air quality

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