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# Implementation of a sustainability monitoring tool into the dynamics of an urban brownfield regeneration project

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**Abstract.** Within the context of post-industrial European cities, the regeneration of urban brownfields contributes to limit urban sprawl by increasing cities density while revitalizing neighborhoods. Yet because of their complex nature, urban brownfields regeneration projects (UBRP) are not automatically sustainable. To foster the integration of sustainability objectives into these projects dynamics, an operational monitoring tool was created. Entitled SIPRIUS+, this tool is a collaborative web-based software combining sustainability indicators adapted to UBRP issues and several management functionalities. Test applications conducted on case studies and presented to the related stakeholders gave positive insights about the potential of SIPRIUS+ to provide decision-making support. However, because of the long duration of UBRP, some aspects inherent to monitoring were not verified and the tool not piloted in real conditions. In order to confront SIPRIUS+ with the reality of the practice and its end-users, the tool is now being implemented for an 18-month period in the Gare-Lac neighborhood project located in Yverdon-les-Bains (Switzerland). The paper investigates how SIPRIUS+ is actually implemented into the project's ongoing urban planning procedure. Then, we analyze preliminary feedbacks to measure the level of adoption of the monitoring approach by the different stakeholders and to identify points of improvement.

## 1. Introduction

Now that it is clear that urban sprawl generates negative impacts on the environment as well as on the economy and the society, post-industrial European cities must steer towards strategic densification of their built-up areas [1]. In this context, the regeneration of urban brownfields is identified as a major opportunity to increase density within the already built fabric and, at the same time, to revitalize declining neighborhoods [2]. This recognition has spread since the last two decades and many land uses policies across Europe foster urban brownfield regeneration projects (UBRP) as a sustainable land take solution [3]. In Switzerland, the revision of the federal law on land planning (LAT) in 2014 introduced new measures to limit urban sprawl by promoting the densification of the urban fabric [4]. As a direct consequence, public authorities must now prioritize urban development within inner areas of the city, using in particular strategies such as the regeneration of urban brownfield [5].

In today's context looking towards the sustainable city, UBRP have to include environmental, social, economic, and governance considerations. However, even though urban brownfields regeneration is a sustainable land take solution at a territorial level, these operations are not automatically sustainable per



se [6]. This is explained first by the inherently complex nature of UBRP: on one side the brownfield site complexities (real or perceived contamination, buildings of variable quality, intermediate neighborhood scale, social stigma, etc.) and, on the other side, the regeneration project complexities (long duration, several stakeholders with different objectives, rigid legal framework, etc.). This adds to the multitude, and sometimes even divergent, parameters of the concept of sustainability to be integrated into the UBRP. Taking simultaneously into consideration these intricate aspects goes far beyond the limits of intuition. To overcome this complexity and to foster a continuous, structured, and proactive integration of sustainability objectives into the project dynamics of UBRP, it is necessary to put systems in place to act on the basis of sound information and to collect it as appropriate [7]. In that order, an operational monitoring tool was created as an outcome of a four-year research project realized at the Ecole Polytechnique Fédérale de Lausanne (EPFL).

Entitled SIPRIUS+, this tool is a collaborative web-based software combining sustainability indicators adapted to UBRP issues and several management functionalities supporting continuous and structured monitoring. We tested SIPRIUS+ on case studies in Switzerland, France, and Belgium and presented the results to the related stakeholders. It gave positive insights about the potential of the tool to provide efficient support for stakeholders involved in the decision-making process of UBRP [8]. However, because of the long duration of UBRP, some aspects inherent to monitoring were not verified and the tool not piloted in actual conditions. In order to confront SIPRIUS+ with the reality of the practice and its end-users, the tool is now being implemented as a pilot experiment for an 18-month period in the Gare-Lac neighborhood project located in Yverdon-les-Bains (Switzerland).

This paper investigates this ongoing pilot experiment. To put the subject into context, the next section presents the functioning of the tool by showing some examples of monitoring visualization results and the outcomes of the interaction with the involved stakeholders. Then, section 3 explains the strategic implementation of SIPRIUS+ into Gare-Lac's urban planning procedure. Section 4 analyses the preliminary feedbacks, which allows to measure the level of adoption of SIPRIUS+ by the various stakeholders and to figure points of improvement for the next phase of the pilot experiment.

## **2. The operational monitoring tool**

The operational monitoring tool SIPRIUS + is an online hybrid tool that combines two approaches: on one side an indicator system along with its evaluation methodology (from the field of the built environment) and, on the other side, a sustainability monitoring software (from the field of business management). Although the issues of the two fields may differ, the principles underlying the monitoring remain the same. The hybridization of these two existing know-how results in a tool using a synergy of the most relevant elements from both disciplines. Thus, while being specifically designed to deal with the issues raised by the integration of sustainability objectives into UBRP, SUPRIUS+ uses several efficient monitoring functionalities (reporting, visualization, planning, management, communication, etc.). More precisely, it enables a comprehensive, continuous and structured assessment and monitoring of a series of quantitative and qualitative holistic sustainability indicators in three categories: Context indicators (21 indicators), Project indicators (23 indicators), and Governance indicators (11 indicators) [8].

Thanks to these tailor-made indicators, SIPRIUS+ offers not only a view on the project environmental, social and economic performances (Project indicators) but goes also beyond traditional evaluative logics at the neighborhood level. On the one hand, it integrates parameters whose influence exceeds the physical limits of the site (Context indicators). For example, indicators related to mobility, environmental impact, proximity to amenities or urban mixing contribute to the project integration on the environmental, social and economic levels within the local fabric. On the other hand, the tool looks at the project management and its dynamics between the multiple actors of the project, as well as the temporal stakes of the process of regeneration (Governance indicators). For example, indicators such as the temporary uses of the brownfield or the degree of participation of the population help the project managers to measure and adjust the various actions in place, which can contribute to change the brownfield site perception and promote acceptance of the regeneration project.

Taken together, these indicators embody the urban strategies used by UBRP to promote the transition towards more sustainable cities. The monitoring of sustainability, using evaluation of indicators and management functionalities, makes it possible to transcribe these various urban strategies and to visualize their performance through time. Thus, monitoring results can contribute to decision-making, that is the trade-offs to be made according to the UBRP’s priorities. To support this idea, we expose here the monitoring results of three representative case studies of UBRP [9]. Indeed, test applications of the SIPRIUS+ tool - previously adapted to the contexts and practices of Belgium, France, and Switzerland - were carried out on the Val Benoit project in Liège (BE), the Pôle Viotte in Besançon (FR), and the Gare-Lac neighborhood in Yverdon-les-Bains (CH). Hereafter, we report the outcomes of the interactions with the stakeholders involved in the case studies.

2.1. Monitoring visualization

SIPRIUS + is a complete monitoring tool, which allows a variety of synoptic visualizations displays of all or part of the indicators in order to facilitate communication according to the target audience. As an example, Figure 1 shows the repartition display for the Expected final situation of the UBRP, that is to say, the foreseeable performances at the end of the regeneration project depending on the elements known at the time of the evaluation. In this case, data are taken from the Masterplans of the three case studies (monitoring performed during 2017 [9]), knowing that some specific indicators were not relevant to the UBRP. The results are distributed according to their levels of performance - Limit Value (VL), Average Value (VA), Target Value (VT) and Best Practice Value (VB) - and represented by a universal color code (from red to dark green). This easy to interpret and to communicate way at looking at the results is a gateway into the monitoring of the UBRP.

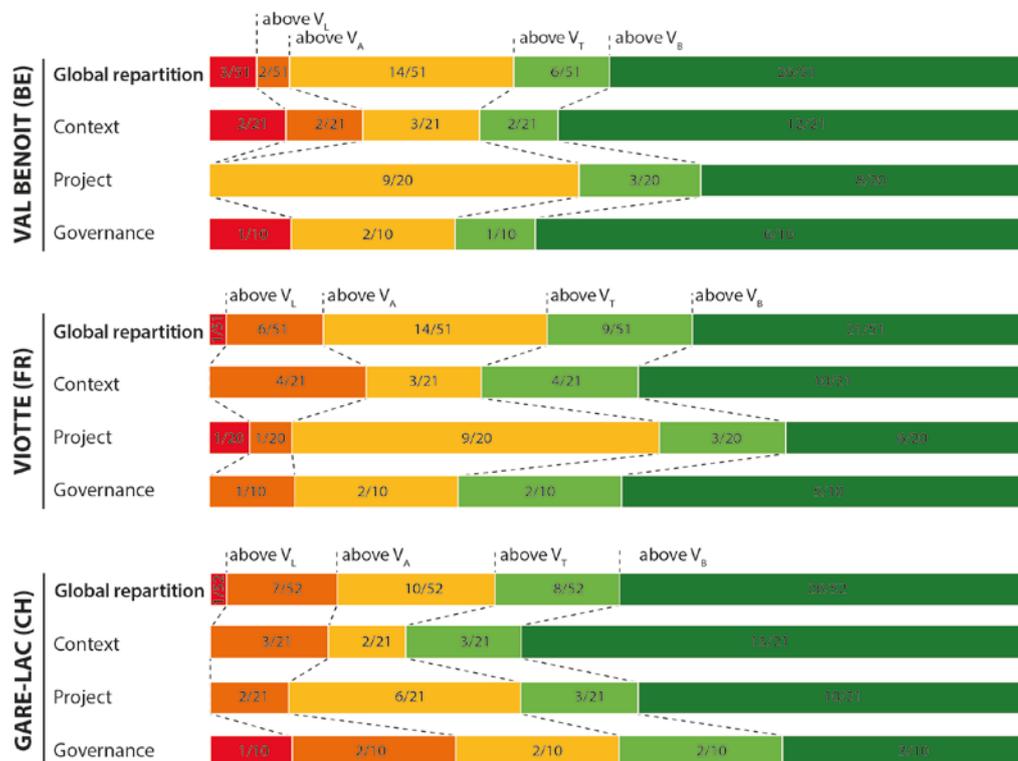
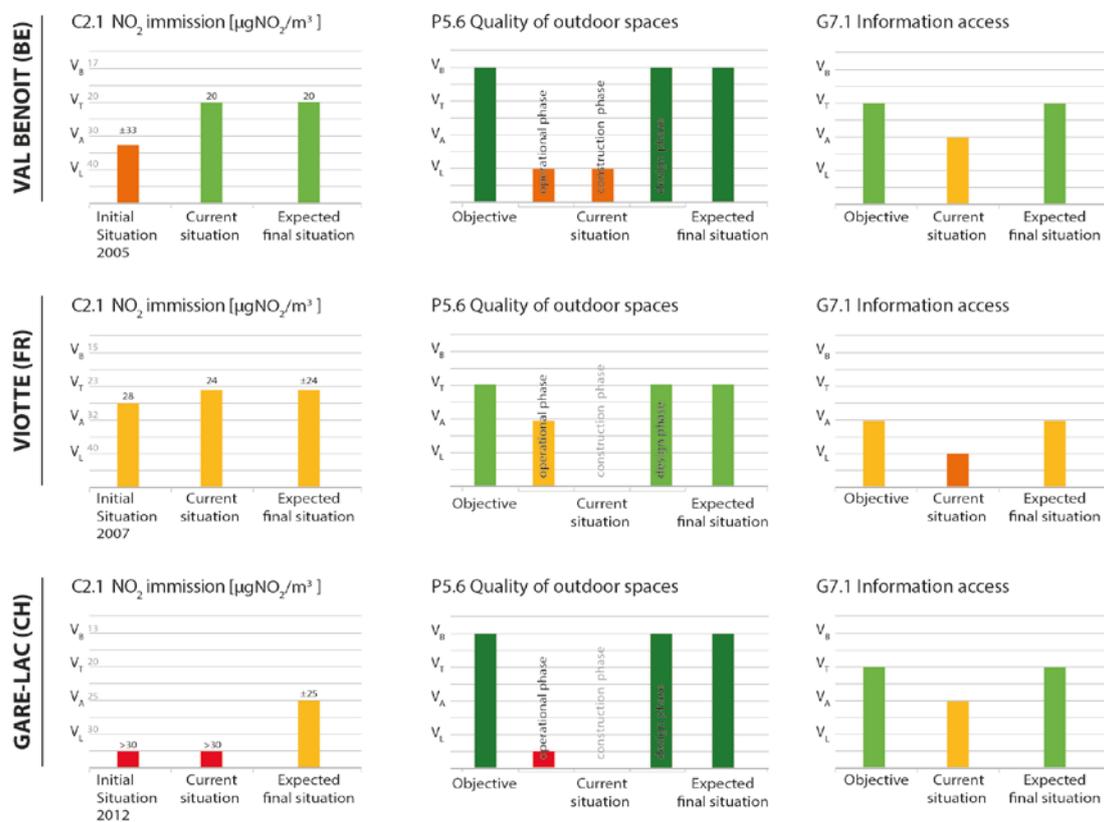


Figure 1. SIPRIUS+ repartition display for the three case studies.

From a monitoring point of view, it is especially interesting to focus on more detailed evaluation results. It makes it possible to see the effects that certain sustainability objectives set by the regeneration project may have on the site improvement, what are precisely the risks, the challenges, and the

opportunities. Figure 2 shows the evolution display of three indicators: Context indicator "C2.1 Average annual emissions of NO<sub>2</sub>", Project indicator "P5.6 Quality of outdoor spaces", and Governance indicator "G7.1 Degree of information access". We observe that the monitoring proposed by the SIPRIUS+ tool allows an evaluation of the Objectives, the Initial situation, the Current situation, and the Expected final situations. These monitoring results are, by definition, the portrait of a situation in a given moment and are subject to change according to the evolution of the projects. It can be used to compare in an iterative way different options of a UBRP, especially during the preliminary phases when the project is the most flexible and offers room for the integration of high sustainability targets. As a general rule, SIPRIUS+ is not designed to compare projects in different locations, nor to rate projects as certain labels.



**Figure 2.** Evolution display of a Context, Project and Governance indicator for each case study. For exhaustive evaluation results see [10].

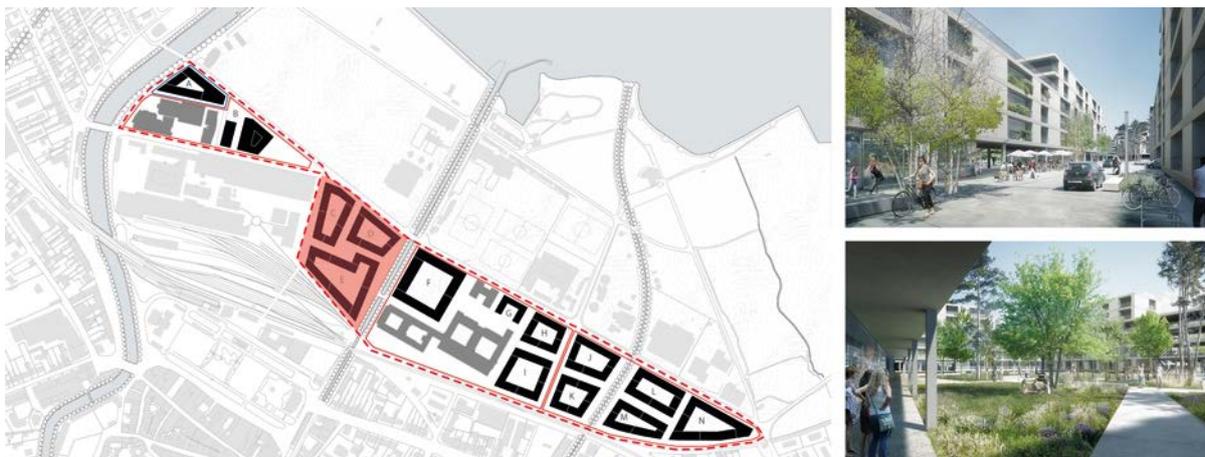
## 2.2. Interactions with stakeholders

The three tests applications confirmed the adequacy of SIPRIUS+ to UBRP specificities as well as the proper functioning of the tool [8]. However, because the concept of monitoring involves taking into account the long-term process of UBRP and because SIPRIUS+ team mostly performed the tests applications, some aspects could not be tested. Therefore, as a complementary test phase, we organized interactions with the involved stakeholders of each case study, which took the form of roundtable discussions. The aim was to face the tool and the test-application results to the future end-users. The participants shared a positive perception about the potential added value of SIPRIUS+, qualifying it as a "dashboard" contributing to the decision-making process. They recognized its potential to facilitate the integration of sustainability issues into the project dynamics 1) by simplifying communication in an interdisciplinary manner, 2) by facilitating follow-up of objectives from the initial situation to the regenerated site, and 3) by fostering a virtuous cycle of iteration of the UBRP. It also emerges from

these interactions that if the use of such a tool implies a change in UBRP management, to include this practice appears not only possible but also realistic and desired.

### 3. From theory to experimentation: strategic implementation of SIPRIUS+

Convinced by the potential of the tool, the stakeholders involved in the Gare-Lac neighborhood UBRP in Yverdon-les-Bains (Switzerland) contacted the SIPRIUS+ team to pursue the monitoring already initiated. This pilot experiment started in July 2018 and will allow, during an 18-month period, to confront SIPRIUS+ with the practice reality and its end-users. This section explains the strategic implementation of SIPRIUS+ into Gare-Lac's urban planning ongoing procedure.



**Figure 3.** Master Plan of the Gare-Lac neighborhood with Ancien-Stand sector in red (left) and perspectives showing architectural, mobility, and landscape quality principles (right).

#### 3.1. The urban planning procedure

Starting from 2006, the multidisciplinary team led by Bauart Architects and Planners Ltd. developed a Masterplan to transform a 23ha urban brownfield into a new sustainable neighborhood called Gare-Lac (Figure 3). Adopted in July 2015, the aim of the Masterplan is to give guidance for a new mixed-use neighborhood providing space for about 3800 inhabitants and 1200 jobs [10]. In particular, the Masterplan requires an optimal density with a ratio of 1,7 Floor space/Plot area, high architectural and landscape quality, and conformity with the primary energy consumption efficiency and CO<sub>2</sub> emission reduction objectives of the 2000 Watts Society [11]. The future neighborhood is composed of 14 plots, organized in 5 sectors. Each of these sectors will be subject to a land use plan (PA - Plan d'Affectation) in order to develop in further detail the Masterplan. This phasing has for advantage to reduce the risk of deadlock related to technical constraint or opposition, to facilitate discussion with landowners, and to sequence the UBRP development. However, it implies major coordination issues between the different PAs to maintain the principles and objectives provided by the Masterplan.

Starting from 2018, the steering committee (COFIL – Comité de Pilotage) composed of the Urbanism Department of Yverdon-les-Bains municipality, the Association for the development of Northern Vaud, and the Operational Group for Urban Centers from the canton of Vaud launched the planning of the PAs to come. The first PA to be developed is the 3,7ha Ancien-Stand sector (Figure 3). It consists of a two-steps public tender procedure. For the first step, it asks for the setting-up of consortiums composed of multidisciplinary offices with competencies in architecture and urbanism, landscape architecture, mobility, environmental studies, and property expertise. The consortiums will have to develop and make a proposition for the PA Ancien-Stand according to the Masterplan. Then, for the second step, the selected consortium will collaborate in an iterative working logic with COFIL until the final approbation of the PA. COFIL will ensure, among other aspects, the overall PA planning and implementation as well as PA compliance with the Masterplan principles and sustainability objectives. It will be supported in this regard by SIPRIUS+, as a pilot experiment.

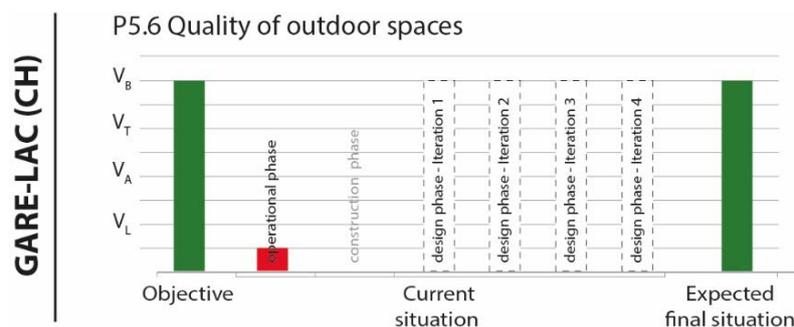
### 3.2. Strategic implementation of the monitoring tool

SIPRIUS+ is designed to monitor sustainability objectives at the neighborhood scale using Context, Project, and Governance indicators. Indeed, the first test-application on the Gare-Lac neighborhood (section 2) - which will serve as a reference for the design of PAs - was performed taking into consideration data from the entire site and the surrounding. Hence to get the same results, the monitoring of the PA Ancien-Stand will have to follow the same methodology. Taking that into consideration, the involved stakeholders could perceive monitoring and evaluation as time-consuming and data collection as cumbersome [12]. Although it is of primary importance for this current urban planning procedure to check conformity with the Masterplan sustainability principles, the monitoring of not one, but several propositions of PAs simultaneously, appears in fact oversized.

To overcome this apprehension, we proceeded here to the strategic implementation of the tool within the PA Ancien-Stand planning procedure adapted to each of the two steps. In that respect, the annex of the call for tender document encloses exhaustive information about SIPRIUS+. It includes SIPRIUS+ catalog of indicators, which gives a detailed description of each indicator, data required to evaluate it, how it is evaluated, and the related references. It also includes the final report showing the results of the test-applications previously realized by SIPRIUS+ team [9].

**3.2.1. Selection step** For the selection step, in order to gain in efficiency, it is asked to the consortiums to described the sustainability concept of their proposition, what is their understanding of the monitoring principles, and how they will organize to provide the data for each indicator in order to feed SIPRIUS+. COPIL will base its decision upon the propositions quality, which includes several parameters of which the integration of SIPRIUS+ monitoring approach in the project dynamics.

**3.2.2. Iterative step** For the iterative step, the selected PA Ancien-Stand will be evaluated following SIPRIUS+ usual monitoring methodology. This means that Context, Project, and Governance indicators are evaluated integrating the new data of the proposition and the data from the entire site. The selected consortium will provide the data according to the project evolution. A team of three urban planners from COPIL will perform the monitoring using SIPRIUS+. The aim is to limit in a first instance the number of users during the procedure until PA Ancien-Stand approbation. This strategic implementation of SIPRIUS+ is a significant aspect of the pilot experiment: it eases the workload of both parties and ensures an incremental use of the tool. Moreover, it provides a common basis creating a shared dialogue on sustainability objectives between the consortium and COPIL.



**Figure 4.** Evolution display – Simulation of the monitoring of different iterations

As an example, Figure 4 shows the monitoring of a Project indicator, which takes into consideration the “Current situation” according to the project advancement (exploitation phase, construction phase, and design phase). In this case, the PA Ancien-Stand corresponds to the design phase. Iterations of the project can be compared in real-time, which gives relevant information about the performances of the PA, consequences of given design choices, and probabilities to meet the sustainability objectives set by the Masterplan. This way, SIPRIUS+ can contribute to the iterative and collaborative working logic between the consortium and COPIL.

#### 4. Preliminary feedbacks and discussion

The selection step of the PA Ancien-Stand planning procedure is currently nearing completion. In total, 10 propositions were received. Among them, four consortiums have not included, or not sufficiently included, the monitoring approach and SIPRIUS+ principles within their proposition. This shortcoming turns out to be critical in the selection of a consortium by COPIL. COPIL will disclose the name of the selected consortium during summer 2019.

This section gathers preliminary feedbacks on this selection step. These feedbacks were collected during an interview with the urban planners' team of COPIL, looking for information about the level of adoption of the monitoring approach in the urban planning procedure so far. We investigate here these preliminary feedbacks by confronting them to the potential added value highlighted previously by the stakeholders during the roundtables interaction (see the 3 points in section 2.2). Then, we identify points of improvement to maximize the benefits of monitoring for the next phase of this pilot experiment, the iterative step, and for further PA procedures.

##### 4.1. Level of adoption of the monitoring approach

The interview revealed that the most qualitative propositions included monitoring principles in a proactive way, using SIPRIUS+ documentation as a "checklist" to verify compliance of the proposed PA Ancien-Stand with the Masterplan sustainability objectives as well as to communicate their performance. Similarly, COPIL uses SIPRIUS+ indicators during the selection step to control that the propositions cover a maximum of sustainability parameters.

It was announced during the interview that two of the three urban planners of COPIL who initiated the PA procedure are now being replaced. As a matter of fact, UBRP are long-term operations and the Gare-Lac neighborhood project is no exception to the rule. Because of that, stakeholders tend to change over time. In this context, the involved urban planners confirmed to rely on SIPRIUS+ to serve as a "dashboard": it will allow to share and transfer the long-term sustainability vision of the Gare-Lac UBRP and to keep up the Masterplan objectives through the project process, such as the 2000 Watts Society objectives.

Although, modest, these preliminary feedbacks are in line with the previously identified potential of SIPRIUS+ (section 2). As a support to decision-making, it can simplify communication in an interdisciplinary manner (point 1) and it can facilitate the follow-up of objectives during the UBRP process (point 2). However, because the iterative step has not started, it is not yet possible to judge the benefits of SIPRIUS+ to foster a virtuous cycle of iteration of the UBRP in that regard (point 3).

##### 4.2. Improvements

This pilot experiment constitutes an innovative way to implement operational monitoring of sustainability objectives into the dynamics of UBRP. Indeed, it presents the advantage to defer on different entities the tasks related to monitoring and evaluation, easing the workload. In the same time, the use of SIPRIUS+ is not imposed but slowly introduced to the external parties, i.e. the consortium. That way, it avoids drastic changes in the usual practice and enhances the tool probability to be adopted later in the procedure. However, we noticed that not all consortiums included monitoring principles into their proposition. The reasons for explaining this neglect must be further investigated (misunderstanding of the monitoring principles, downplaying of sustainability objectives importance, fear of work overload, etc.). In any case, it shows that operational monitoring still a novelty in current practice; the PAs documentation to come could include a more exhaustive explanation about SIPRIUS+ approach.

SIPRIUS+ has the potential to offer a framework to promote the dialogue between the different stakeholders and the sharing of responsibilities on the project. For the time being, the strategic implementation limits the online access to SIPRIUS+ to the COPIL urban planners team. It may have the effect that members of the consortium feel not fully implicated in the sustainability monitoring of the project. Depending on this consideration, we suggest as an improvement to include later on one member of the consortium as a user of SIPRIUS+. This possibility will be discussed with COPIL upon the first round of iteration.

## 5. Conclusion

The transition towards a more sustainable built environment is the way forward. Urban brownfields regeneration projects (UBRP) can contribute to this important transition challenge but are not inherently sustainable. A research project proposes an operational monitoring tool facilitating the transformation of urban brownfields into tomorrow's sustainable neighborhoods. Entitled SIPRIUS+, the tool was tested on case studies and the results discussed with the involved stakeholders. In order to face SIPRIUS+ to the reality of the practice and to its future end-users, an 18-month pilot experiment is now ongoing on the Gare-Lac neighborhood in Yverdon-les-Bains (Switzerland). It is based on the strategic implementation of SIPRIUS+ into the urban planning procedure. It constitutes an innovative way to implement operational monitoring of sustainability objectives into the dynamics of an urban brownfield regeneration project. It eases the workload related to monitoring and evaluation and slowly introduces the tool to external parties. Preliminary feedbacks confirm the potential of SIPRIUS+ to contribute concretely to the actual practice by offering new means to integrate and follow sustainability objectives. For the purpose of continuous improvement, further investigations are expected at the end of the pilot experiment, including the analyses of the monitoring results as a support to the decision-making process.

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