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## TOWARD SUSTAINABLE REGENERATION OF DISUSED URBAN AREAS: A MONITORING TOOL TO INTEGRATE ASSESSMENT INTO THE PROJECT DYNAMICS



Fig 1: The Gare-Lac neighborhood, a disused urban area in Yverdon-les-Bains (Switzerland)

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WHICH ARE YOUR ARCHITECTURAL (R)SOLUTIONS TO THE SOCIAL, ENVIRONMENTAL AND ECONOMIC CHALLENGES OF TODAY? Increase density; Tools development (software); Urban regeneration

### Research summary

Regeneration of disused urban areas, such as industrial brownfields or abandoned infrastructural zones, has received considerable attention in the context of post-industrial European cities. Indeed, these projects offer great opportunities for the densification and revitalization of the existing built fabric as well as for the limitation of urban sprawl. By addressing neighborhood scale, initiatives of this type can potentially have global positive impacts on environment, economy and communities of cities and are now strongly fostered by land use policies.

Despite all this, due to the inherent complexity of urban regeneration projects, a holistic integration of sustainability objectives is far from being an automatic process. It depends upon a proactive search for global quality, integrated in a participative way in the project dynamics and a structured and continuous assessment of environmental, economic and social dimensions of sustainability, tailored to the specificities of such projects.

Specifically focusing on these challenges, the ongoing research presented in this paper aims at developing a monitoring tool entitled SIPRIUS+. This new generation tool is a hybrid between a sustainability indicator system adapted to the issues raised by the regeneration of disused urban areas and a user-friendly, web-based monitoring software. SIPRIUS+ is designed to provide a strong basis to key stakeholders involved in the management of these projects and facilitates communication and participation with various public or private actors.

This paper gives an overview of these objectives and a description of the steps of the tool's design. Preliminary findings leading to future adaptations are presented through a case study: the Gare-Lac neighborhood, a large disused urban area located in the city of Yverdon-les-Bains (Switzerland).

**Keywords:** disused urban areas, urban regeneration, sustainability assessment, indicator system, monitoring tool.

## 1. Introduction

It is now widely recognized, urban sprawl generates global negative impacts on the environment, financial surcharge and social inequity (Couch et al., 2007; EEA & OPOCE, 2006). Following the compact and polycentric city model (Rogers & Gumuchdian, 1998; Williams et al., 2000), the regeneration of disused urban areas (DUA) provides a valuable opportunity to limit this problem but also to revitalize and densify portions of post-industrial European cities.

Regeneration of DUA is now strongly fostered by land use policies as a sustainable land take solution at territorial level (European Commission, 2013). However, taken individually, these projects do not automatically satisfy the conditions to reach more sustainable cities (Eisen, 1999). Quite often, DUA regeneration projects refer only partially to sustainability, giving priority to environmental considerations and leaving aside social and economic aspects of sustainable development (Andres & Bochet, 2010; Dixon, 2006).

In reality, reaching high levels of performance in terms of sustainability implies to deal with a large number of parameters which goes beyond simple intuition. This adds to the complex nature of DUA's regeneration projects, which involves considering both the specificities of the site (between city and building scale, negative connotation, different constructions of variable size and quality, etc.) and the specificities of the project process (long duration, various stakeholders involved, etc.).

Consequently, there is a strong need for "tailor-made" assessment methods gathering sound information in order to provide decision-makers with a realistic account of a given situation (Sharifi & Murayama, 2013). Besides, recent works have encouraged

looking at dynamic assessment of sustainability and have shown that static evaluation is not sufficient (Brandon & Lombardi, 2010).

These demands can be satisfied with an operational assessment integrated into the project dynamics. Essentially, it must meet the following requirements: (1) a search for global quality integrated in the project dynamics; (2) a monitoring of the economic, social and environmental performances ; (3) an adapted set of parameters, specific to the site and the project process of this type of operation (Rey, 2012).

In this perspective, a multitude of sustainability assessment tools have been created in the last decade. However, a recent survey identified only few methods related to DUA (Laprise et al., 2015). Moreover, it revealed that they do not fully meet the integrated operational assessment's requirements. Especially, they cannot truly ensure a constant follow-up of sustainability issues throughout the project.

In order to fill this gap, a research project entitled SIPRIUS+ is currently being conducted at (*blinded*) to create a new sustainability monitoring tool tailored to DUA regeneration projects. This innovative research project is based on a hybridization strategy, which aims at combining tools from two different fields: built environment and business management.

Building on this as a theoretical basis, the purpose of this paper is to present general and specific objectives as well as the approach adopted for the initial stage of development of SIPRIUS+. Through different test-applications on a case study, the paper also highlights the main findings and translates them into steps that should be taken for future adaptations.

## 2. Research objectives

### 2.1 General objective

The general objective of this research is to develop a monitoring tool that meets the requirements of an operational assessment integrated into the project dynamics. Preliminary investigation revealed that efficient digital monitoring tools are used in many diverse fields where the management of sustainability issues is needed (Authors, date). While indicators may differ, methods used for sustainability monitoring in businesses or project development have considerable similarities. Thus, instead of starting from scratch, the chosen strategy is to take advantage of an existing monitoring tool as a basis and to integrate the adequate existing indicator system. An extensive analysis led us to the selection of two complementary tools that together have the potential to fulfill the expected requirements: the theoretical indicator system SIPRIUS and the web-based monitoring tool OKPILOT. The result of this hybridization process is entitled SIPRIUS+ (Fig 2).

#### 2.1.1 Theoretical indicator system

SIPRIUS is a theoretical indicator system precisely designed for the sustainability assessment of DUA regeneration projects. A successful preliminary application of SIPRIUS

on a project under construction revealed that it sets basis to assess and visualize performances of different stages of a project. Results have been discussed in few publications (Authors, date; Authors, date). However, it also highlights that integrating the assessment into the project dynamics depends primarily on the involvement and motivation of stakeholders. Because it is not operational in the context of daily practice, a constant follow-up of sustainability issues is not reasonably feasible.

#### 2.1.1 Operational monitoring tool

OKPILOT is an operational monitoring tool developed as a SaaS (Software as a Service), which ensures smooth implementation, simple maintenance and lower operating costs (GLOBALITE Management, 2014). It is designed to support businesses and public organizations in setting, managing and reaching objectives. It offers several monitoring functionalities to assess corporate sustainability but also social responsibilities, quality, performance or health and safety. In that sense, it is highly business-oriented and not specifically adapted to the built environment. However, a preliminary investigation revealed the technical feasibility to adapt OKPILOT to the field of the built environment (Authors, date).

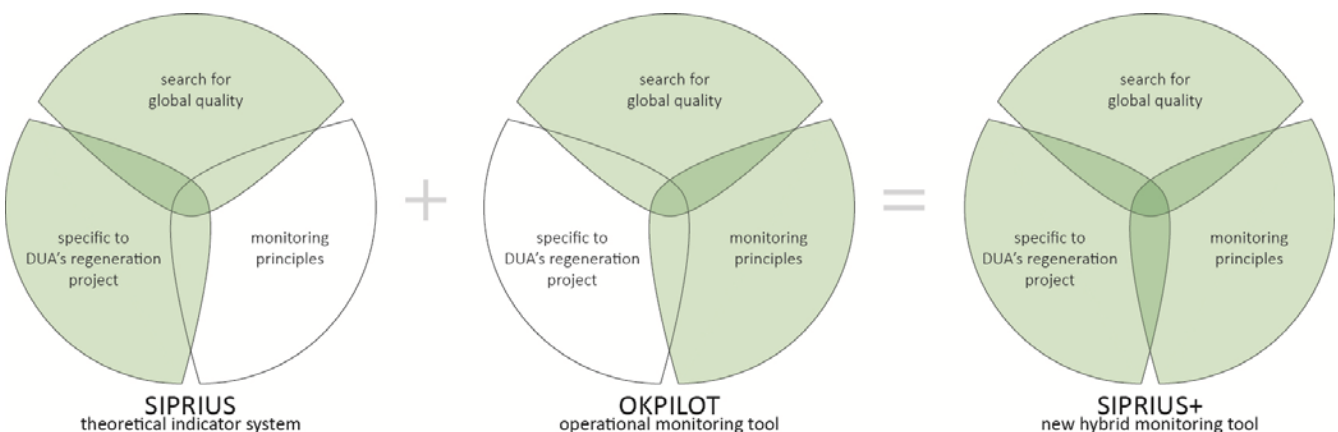


Fig 2: Hybridization strategy to fulfil the requirements of an integrated operational assessment.

## 2.2 Specific objectives

In developing the new hybrid monitoring tool, special attention must be given to the assessment phases. Indeed, the monitoring tool must cover several phases and bring them together. It must simultaneously give overviews and precise pictures of the project's performances (Table 1). In addition, the tool must provide specific features that are intrinsic to monitoring principles (Table 2).

Table 1: Assessment phases

Assessment phases	Description
<i>ex ante</i> assessment	Prospective evaluation. Diagnosis of the initial situation and objective settings. Estimation and critical analysis of expected performances.
<i>in itinere</i> assessment	Support evaluation. Structured and regular verification. Problem-solving, optimization and fine-tuning. Connects various stages of the project.
<i>ex post</i> assessment	Summative evaluation. Synthesis of the project's performances. Analysis of actual and expected values. Gathering of new knowledge and experiences.

Table 2: Specific features

Features	Description
Access to database	It provides structured information and references on sustainability issues to allow consistency and transparency of the evaluation.
Diversity of indicators	It integrates qualitative and quantitative indicators which can evolve with the characteristics of the project.
Iteration of the project	It is used to test options and optimize the project according to the results of the assessment and to a constant evolving dynamics.
General simplicity	It must be simple to use and to understand. It provides easy-to-navigate interface.
Good communication	It offers different analysis and reports of the results, communicable to a majority of stakeholders from various backgrounds.
Integration	It applies to a variety of regeneration

to general practice	projects of disused urban areas and is extended to the general practice.
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## 3. Approach

### 3.1 Iterative development

In order to fulfill the general research objective, the project is organized around three interconnected key steps.

Table 3: Interconnected key steps

Steps	Description
Adaptation of SIPRIUS	Update of SIPRIUS to reflect the current challenges of sustainability in a search for global quality.
Adaptation of OKPILOT	Transposition of SIPRIUS into the monitoring tool by executing a series of programming, development and customization of OKPILOT.
Validation of SIPRIUS+	In parallel with the two adaptation steps, cases studies will be selected and assessed in order to feed, optimize and validate SIPRIUS, OKPILOT and subsequently SIPRIUS+.

These steps are part of an iterative process that involves, in the initial stage, to go back and forth between a case study and the adaptation of SIPRIUS and OKPILOT. Therefore, results presented in this paper provide cross-cutting inputs for the development of SIPRIUS+.

### 3.2 Case study

More specifically, the approach consists of the double assessment of a DUA's regeneration project, namely the Gare-Lac neighborhood located in the heart of the city of Yverdon-les-Bains (Switzerland). The Gare-Lac neighborhood is a true archetype of DUA. It is literally cut off from the city center by railway tracks. Without an identity of its own, it is characterized by a mix of vacant lots and declining industries. In 2006-2007, the team led by Bauart Architects and Urban Planners Ltd won the urbanism competition on the

Gare-Lac area (URBAT et al., 2012). The master plan was delivered in 2014 and includes a 23 ha sustainable neighborhood (Fig 3).

The present research focuses on this section of the master plan. On one side, we performed a test application with the theoretical indicator system SIPRIUS. On the other side, we conducted an experimental evaluation with OKPILOT. Both assessments contribute to identify precisely which actions should be taken in priority to develop SIPRIUS+. Results are analyzed and findings translated into future adaptations.



Fig 3: The master plan of the Gare-Lac area includes a 23 ha sustainable neighborhood (URBAT et al., 2012).

## 4. Results and design potential

### 4.1 Results and future adaptation of SIPRIUS

First issued in 2006, the theoretical indicator system SIPRIUS is divided into criteria of context (aspects which implications go beyond the site's limit) and criteria of project (aspects which implications stay in the site's limit), evenly distributed among the three pillars of sustainability. They are evaluated by qualitative or quantitative indicators and measured by four reference values: Limit Value ( $V_L$ ), Average Value ( $V_A$ ), Target Value ( $V_T$ ) and Best practice Value ( $V_B$ ). We used the

42 indicators to assess the Gare-lac neighborhood. Fig 4 shows a sample of three typical indicators related to the context in a synoptic table that allows to simultaneously compare results of different type of indicators, at different stages of the project.

Because the master plan is an early stage in the regeneration of a DUA, the project is not clearly defined and information rather meager. Hence, not all indicators could be assessed. Only 30 indicators could be measured without having to make additional studies. Global results are generally positive with 70% of the indicators above the Best practice Value ( $V_B$ ). Besides, first assessment turns out to be of critical importance in order to set sustainability objectives and to raise awareness about potential problems. Indeed, decisions taken at this step will have the biggest impact on the sustainability of the project, and on its entire life cycle (Boyko et al., 2006). In addition, the synoptic table proved to be an effective means for communication and analysis. It sets basis for future development.

Apart from confirming the relevance of the indicator system and providing a clear vision of the sustainability performances of Gare-Lac neighborhood, the test application revealed several shortcomings. In that sense, it feeds the key steps related to the adaptation of SIPRIUS by highlighting three main actions to take:

1. **Update:** Knowledge and techniques are evolving constantly. The reference values must be updated to comply with current standards and norms and to reflect the most recent best practices. It includes the gathering of all relevant resources to measure each indicator.

2. **Complete:** New indicators relating to the context and to the project must be created to complete the indicator system. Indeed, the

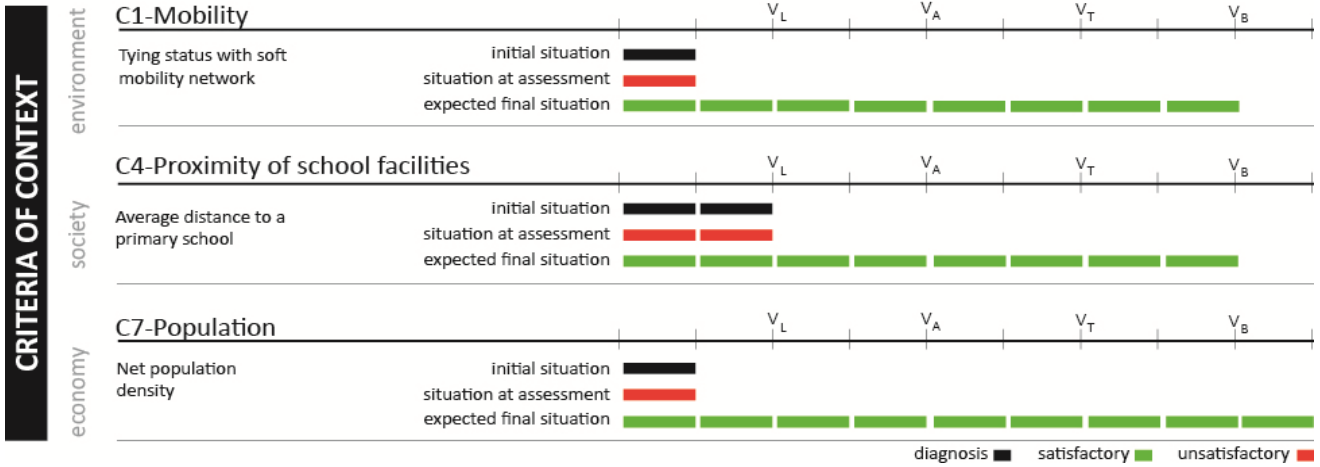


Fig 4: Results of the SIPRIUS test application on Gare-Lac neighbourhood in a synoptic table.

indicator system must widely cover sustainability aspects at neighborhood scale and reflect concerns of DUA's regeneration project.

3. Enhance: A search for global quality is a holistic vision which includes the "three pillars" of sustainability, as well as aspects regarding the project management and the project process (Sharifi & Murayama, 2013). A full list of criteria and indicators related to this "fourth pillar" must be created such as the evaluation of the participation process or the level of transparency.

#### 4.2 Results and future adaptation of OKPILOT

OKPILOT works as a platform that offers several functionalities to assess and monitor the sustainability of an object by integrating different checklists of indicators. In order to evaluate the Gare-Lac neighborhood with OKPILOT, we have directly integrated a set of context indicators extracted from SIPRIUS in the monitoring tool, thus simulating a simple checklist. Fig 5 reports the results of the assessment in a standard bar chart.

This experimental evaluation revealed that the user-friendly and collaborative features of OKPILOT such as objective-setting, risk identification or creation of deadlines are significant solutions to monitor the

sustainability of a DUA regeneration project. In that regard, OKPILOT contributes to integrate the assessment into the project dynamics and could improve the global quality of the Gare-Lac neighborhood regeneration project. Again, if the early stage of a project proves to be the ideal moment to undertake sustainability assessment, it is also the right time to take it further with a monitoring process.

Nevertheless, this experimental evaluation provided limited results in terms of evaluation and visualization of the indicators in compliance with SIPRIUS. For instance, some inconsistencies can easily be identified by comparing the results table of OKPILOT (Fig 5) with the synoptic table provided by SIPRIUS (Fig 4): lack of transparency of each criterion, aggregated indicators, values in percentages, etc. Actually, despite integrating SIPRIUS as a checklist, OKPILOT is not yet adapted to the assessment and the monitoring of DUA regeneration project and addresses other requirements.

Without giving any clear results in terms of the sustainability performance of Gare-Lac neighborhood, this experimental evaluation still confirms the potential of the tool and its features and provides a valuable feedback for the future adaption of OKPILOT.

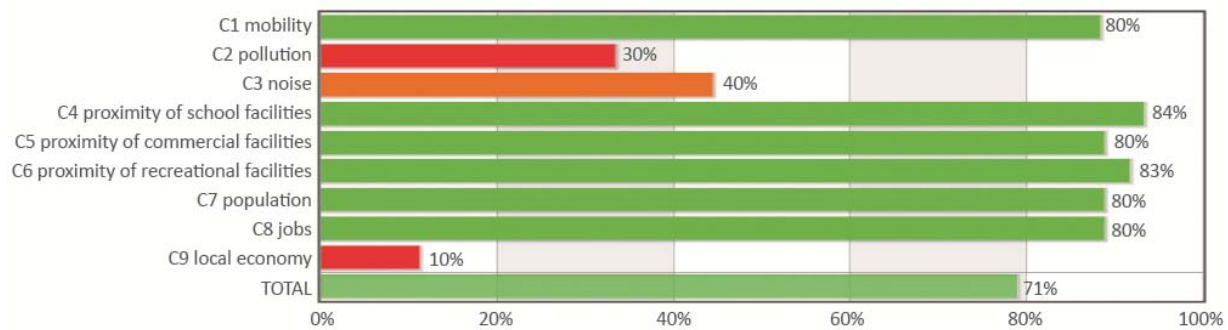


Fig 5: Results of the OKPILOT experimental evaluation on Gare-Lac neighborhood in a bar chart.

1. **Resources:** All relevant data sources, information and methods must be available to evaluate each indicator properly.
2. **Relevance:** A function must be developed to choose the most relevant indicators to assess a project. A list of mandatory indicators must also be provided.
3. **Tree diagram:** Assessment is divided into two levels: indicators and criteria. An additional level must be created to reflect the environmental, social and economic aspects as well as aspects related to the “fourth pillar”.
4. **Reference value:** Indicators are measured with relative values (percentages). Development of measurement with absolute values (four reference values  $V_L$ ,  $V_A$ ,  $V_T$  and  $V_B$ ) is needed.
5. **Graphical display:** Result tables must reflect the synoptic table proposed by SIPRIUS by showing each indicator, at different stages of the project.
6. **Reports:** Reports must be adapted to reflect a wide range of general data linked to DUA regeneration projects (sustainability profile, objectives, issues, phase, etc.).

## 5. Future implementation

By means of an adaptation work of OKPILOT and SIPRIUS, the new hybrid monitoring tool SIPRIUS+ will be developed with its own

specificity in terms of content and its own identity in terms of visualization. According to preliminary results on the Gare-Lac neighborhood, SIPRIUS+ is most likely to fulfil the requirements of an integrated operational assessment by including a search for global quality and monitoring principles both adapted to DUA regeneration projects. Likewise, future adaptations will address specific objectives identified in table 1 and 2. SIPRIUS+ alone will not guarantee the environmental, social and economic success of a project. However, this collaborative tool aims at facilitating the integration, assessment and follow-up of sustainability issues in complex DUA regeneration projects. In this sense, it contributes to decision-making, helps communication and participation with various public or private actors and promotes more sustainable neighborhoods.

The iterative development of SIPRIUS+ involves validation through case studies. In that order, it will need to be tested on other typical DUA regeneration projects, at different stages and in different contexts. The research team is now in contact with stakeholders involved in this kind of projects. This step will also allow identifying the primary target audience of the tool (private property developers, local authorities, professional advisors, etc.) by measuring their level of interest.



## 6. Conclusion

Sustainability is not inherent to DUA regeneration projects, consequently an adapted monitoring tool is necessary for its integration. SIPRIUS+ is a new hybrid monitoring tool combining two complementary tools from different fields: SIPRIUS and OKPILOT. The initial stage of the iterative development of SIPRIUS+ consists in testing the two basic tools on a case study, the Gare-Lac neighborhood in Yverdon-les-Bains (Switzerland). Results are analyzed and then translated into actions that need to be taken to adapt both SIPRIUS and OKPILOT. The resulting new monitoring tool is expected to significantly contribute to the integration of sustainability issues into the project dynamic of DUA regeneration projects by providing stakeholders with the adequate means to make informed decisions. The adaptation of SIPRIUS is now well underway, research is currently starting with the adaptation of OKPILOT.

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