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ENVIRONMENTAL ASSESSMENT OF A BROWNFIELD REGENERATION PROJECT USING INTEGRATED SUSTAINABLE DEVELOPMENT INDICATOR SYSTEM (ISDIS)

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Abstract- Urban brownfields represents an interesting surfaces potential to regain. Regeneration allows to consider simultaneously an intensification within the already built tissue, and a revitalization of cities portions and towns. If in recent years, a considerable number of projects of this type is observed in Algeria; however, it is most often found that they are not related to the environmental dimension. In response to this reality, this contribution will analyze in detail the multiple interactions linking the reconquest of urban brownfields and the environmental dimension. We want through this article offer an environmental assessment methodology, developed from the characteristics of urban brownfields projects, and will be tested by an application which is representative of the project's problem in Ruisseau/Abattoirs neighborhood in Algiers. The result of the article will constitute an indicators catalog using "ISDIS" tool: integrated sustainable development indicators system, that will provide practitioners and policy makers with an evaluation methodology that meet their business needs, it will constitute in this sense a tool for increased integration of environmental considerations into regeneration projects.

Keywords: ISDIS Indicators, Brownfields Regeneration, Environmental Dimension, Algiers, Environmental Monitoring.

1. INTRODUCTION

The city of Algiers knows, since the beginning of the 21st century, a significant change of its urban landscape, consequence of big urban works. These mutations are visible and spectacular in the surrounding eastern neighborhoods: (Belcourt, El Hamma, Ruisseau, Abattoirs, Hussein Dey, El Harrach); they are mixed industrial neighborhoods containing many urban brownfields and suffering from many operational problems with social, economic, and environmental consequences [1]. The changes that these neighborhoods undergo are mainly characterized to our days, by the complete demolition of entire blocks and the partial reconstruction of public or tertiary buildings [2].

2. BROWNFIELDS REGENERATION AND ENVIRONMENTAL DIMENSION PROBLEM

We have highlighted that a significant contribution to the relationship between environmental aspects and urban regeneration, in both qualitative and quantitative level, is far from being automatic, and it involves integration of global quality research, specific to the project. The practical success of this process in particular requires active monitoring of the multiple dimensions of sustainability [3]. The analysis of the main types of evaluative approaches currently available, at the urban-architectural scale, shows that the latter are not sufficiently adapted to support effectively this monitoring process [4]. As noted by Stratis (2005) [5], "*the fact of positioning our thoughts on this scale called "urban-architectural" allows as to move our point of view from "an understanding of the territory as a set of objects and actors localized, to a territory of interactions, of shared memory and projects."*

The objective here is to provide concrete answers to the following questions: What are the different forms of interaction between the recapture of urban brownfields, and the environmental dimension in this project? The methods available to the actors in charge of the factory of the city of Algiers, are they adapted to ensure brownfields' winning back in a sustainable manner?

In premature response to the questions that we have just formulated below, we believe that interactions are not necessarily automatic and a strong contribution of the regeneration of urban brownfields vis-à-vis the SD of the built environment goes through the incorporation of certain conditions [6].

From first glance, it appears clear that the two concepts are highly related, their modes of interaction are multiple and complementary, first the regaining project must be respectful of sustainable development and environmental dimension principles, as rebuild city onto itself using hollow teeth without consuming new greenfields, is a reply to urban sprawl [7] , on the other hand the environmental dimension must supply the regeneration project with components and critical data ensuring its success over the long term [8] with a view to environmental enhancement. This interactive approach can be effective on local scale

without specific methodology adapted to the environmental assessment and regeneration project itself.

In parallel, it is necessary to determine the criteria likely to promote sustainable urban regeneration in order to prepare the sitting for the process of environmental assessment.

3. URBAN REGENERATION (UR) AS A SUSTAINABLE ALTERNATIVE TO URBAN SPRAWL

In terms of the evolution and development of cities, current trends tend to focus on promoting re-urbanization, densification, and return to the city, while it seems unarguable that urban regeneration has, and will have, An important role for cities development. In addition, as we will see below, UR is an opportunity to achieve sustainable and resilient development, energy efficiency, rational land use, and the revitalization of traditional city centers [9, 10]. Furthermore, translating sustainable development into practical dimensions will necessarily imply the development of strategies at the urban level [11].

Given the high percentage of the Algerian population living in urban zones, the peripheral areas of cities are experiencing increasing growth, which is predicted to lead to the appearance of the phenomenon of "suburbanization" (already the case for the capital Algiers). At the same time medium-sized cities (from 50,000 to 100,000 inhabitants), intended to replace large cities, are registering accelerated growth and smaller towns (of between 20,000 and 50,000 inhabitants) continue to attract populations from rural areas and other urban agglomerations.

The growth prospects of Algerian (and Mediterranean) cities only prefigure a worsening of already worrying current problems: excessive land consumption (soil artificialization, irreversible loss of arable land); an increasing degradation of the built heritage; pollution of groundwater; ineffective waste management; and the cumulative effects of all these factors on the environment and on population health [12].

Accelerated urbanization is already accompanied by massive demand for housing and infrastructure while urban management problems are recurrent, and this situation may become even more complicated in the future. Indeed, according to the website of the Algerian National Statistics Office (ONS), on January 1st, 2018, the total population of Algeria reached 42.2 million, with more than 70% of this population being urban, and this rate should reach 85% by 2050. As shown in the following graph.

In this context, the growing recognition of the importance of urban regeneration and its relationship with the environmental dimension has been attested by several policies, laws and instruments on an international scale: the Europe 2020 strategy; the Amsterdam Pact; the Toledo Declaration; the Leipzig Charter; the Paris Agreement; and the 2030 Sustainable Development Goals.

In addition, as several authors have mentioned, other economic and social benefits also derive from the reduction of energy and GHG emissions through an effective policy of brownfields regeneration. These include: reducing the costs of services relating to household energy [13] ; reducing air pollution at local and regional level [14]; improving life quality inside buildings due to the amelioration of hygrothermal comfort; enhancing indoor air quality through the use of more efficient ventilation systems; and raising acoustic comfort through the use of double or triple-glazed windows [15]. Thanks to its role in increasing productivity through working in low-energy buildings [16], or LEB, and increasing overall economic activity, through investments in urban regeneration, urban regeneration represents an excellent opportunity, for radically transforming and repurposing the city with an emphasis on a model of sustainable growth.

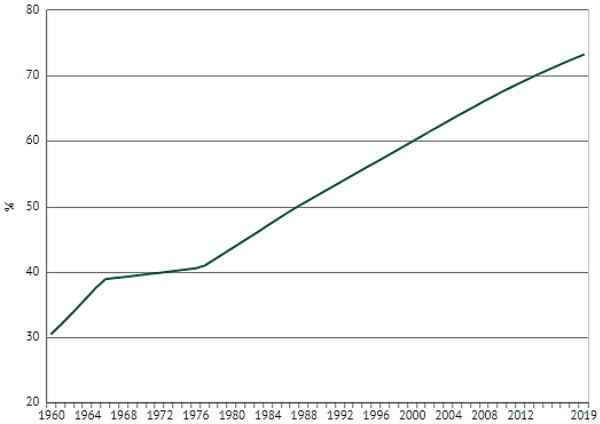

Figure 1. Algeria urban population
(Source: UN World Urbanization Prospects, 2018)

Brownfields redevelopment is also an opportunity to modify their uses, creating a more diversified form of land use, to improve local economic activity and further reduce transport needs [17]. In fact, the relation between land use and energy consumption linked to transport has been discussed by many researchers, particularly with regard to the environmental impacts of urban sprawl [18], [19 and 20]. Urban regeneration allows for a dense and mixed development of cities (with their functional mix of: housing, businesses and services), and facilitates the mobility of populations given the reduced distances that people have to travel to their destinations. This, combined with improved public transport systems, encourages changes to modes of travel and to travel behavior that discourage car use, which in turn reduces energy consumption for transportation.

4. DENSIFICATION BY BROWNFIELDS: A CONTRIBUTION TO SUSTAINABILITY

4.1. The Concept of Brownfield

Urban neglected areas, hollow teeth, black pastilles, empty spaces or pockets. Abandonment, caesura, crisis. There have been many negative expressions used to define brownfields. But do they really deserve all these derogatory epithets?

Nowadays, with urban planners and architects viewing abandoned urban sites as a resource, their regeneration has become popular, as the number of city dwellers has grown,

and as cities have come under pressure to receive more inhabitants, without going beyond the perimeter already built. Poorly connected spaces consume land and destroy the landscape. Studies have shown that they consume more energy, they are dependent on the car, with infrastructure costs which remain higher than those in dense areas. [21, 22, 23 and 24].

Urban brownfields are at the center of conflicts around socio-cultural, economic, and historical arguments, policies and approaches, which today are being increasingly viewed through an environmental prism. The common notion remains that brownfields have no value until they are developed. However, they play a unique and valuable role in the future of city dwellers, as people increasingly reassess traditional notions of progress and seek more sustainable patterns of life. Brownfields support the biodiversity of the city center and its peri-central districts, provide carbon sinks [25], improve hydrological mitigation, offer open spaces and represent the freedom of the controlled built environment. Like metaphors, the issue of brownfields characterizes the cause and effect of our constant and continuing (re)-development.

"Promoting the idea of brownfield is obviously a politically sensitive idea, because brownfield is a symbol of the withdrawal of public authorities - withdrawal, not abandonment". Writes Gilles Clement, landscaper and gardener, in 2017, as he integrates brownfields into his concept of a 'garden in motion'. He recalls that brownfields land has always existed. History denounces the as a "loss of human power over nature" ", and, he goes on to ask, "what if we looked at them differently?" "The author insists that the redevelopment of a soil by nature is in no way a degradation, as many people think, and pondered "the man who gained ground, cannot it yield?" "He regrets the fact that the term 'brownfields' "is so devalued when it takes on connotations of the extreme; "It is also in the 'brownfield' that we find the plants with the greatest ecological range" [26].

Brownfields redevelopment is considered as being at the heart of urban regeneration, favoring the production of a denser city, which is continually rebuilding on itself. Brownfields are then explicitly represented as "unique opportunities for an inward development of the city", and Emmanuel Rey emphasizes in 2006 that their redevelopment allows simultaneously a densification inside the already built fabric and a revitalization of certain portions of cities and agglomerations.

5. ADOPTED METHODOLOGY FOR ENVIRONMENTAL ASSESSMENT

We noticed that introducing environmental questions into brownfields regeneration projects involves the establishment of a specific evaluation methodology. Given the specific features of these projects, evaluative approaches currently available for active use by practitioners and policy makers in the city of Algiers, are not fully adapted to the stakes in this case, it is very important to be able to design and sketch a sufficiently operational methodology for their evaluation [27]. The development of a performant indicators system, which could provide policy makers and practitioners with real assistance in monitoring, is the main objective of this research.

- A. The HEQ2R (high environmental quality for urban Renewal and Regeneration) method for a sustainable regeneration of urban brownfields

This approach crosses the goals of sustainable development with principles of action for a sustainable urban regeneration. These sustainable development objectives are broken down into targets, sub-targets and indicators and constitute the Integrated Sustainable Development Indicators System (ISDIS), which structures the approach and its main tools.

It is composed of operational tools for each of the 4 phases of a territorial project, including the HQDIL method (Diagnosis method) which allows the development of a shared sustainable development diagnosis and the INDI (Indicators impact) [28] evaluation model of a territory or brownfields regeneration projects:

- B. The 5 goals and 21 targets of sustainable development constituting the ISDIS system

The Table 1 explains in detail the 5 objectives and the 21 sustainable development targets. Thus, for each of these themes, a set of questions to ask allows to realize the inventory. These questions are also related to both structures and uses Table 2.

5.1. The Ruisseau/Abattoirs District Diagnosis Using the HQDIL Method

Three stages were distinguished for a shared sustainable development diagnosis of the Ruisseau/Abattoirs territory:

- The preliminary inventory (collection of available information) and the sharing of the inventory,
- Systemic analysis, heart of diagnosis, and sharing of analysis,
- Definition of sustainable development issues for the neighborhood, and choice of objectives for the neighborhood (with the ranking of targets or sub-targets selected).

5.2. The Neighborhood Inventory

The analysis grid crosses (through 20 themes) each of the four types of elements of a neighborhood (residential construction, non-residential construction, open external spaces, infrastructures) with each of the five objectives (and each of the 21 targets) constituting the ISDIS system.

Table 1. The analysis elements of the neighborhood

Elements of the neighborhood	Structure	Use
Residential Area	Housing stock, volume and quality of buildings	Population by age, status, occupation, energy consumption, etc.
Non Residential Area	Housing stock, volume and quality of buildings	Types of users coming or not from the neighborhood
Not built Space	Green spaces, quality	Use, cleanliness, security, etc.
Infrastructure and networks	Length and quality of roads, road networks, public transport ...	Mobility, intermodal distribution, flow of energy consumption, water, etc.

Table 2. Five goals and 21 SD targets of the ISDIS

Questions	Objectives	Targets
Does the regeneration project take into account the preservation of the heritage and natural resources?	1- Preserve heritage and natural resources	1- Reduce energy consumption 2- Resource management 3- Land management (against urban sprawl) 4- Materials management (raw materials) 5- Protect nature and heritage
Does The project incorporate environmental quality?	2- Improve the quality of local environment	6- Improve landscape quality 7- Improve housing quality 8- Improve health 9- Improve risk management in neighborhoods 10- Air quality 11- Acoustic comfort 12- improve waste management
Does the project include the functional and social diversity?	3- Insure diversity	13- Population diversity 14- Functions diversity 15- Housing diversity
Does the project promote the integration of people with different equipment and functions of the city?	4- Improve social integration	16- Improve education and professional integration 17- Access to employment 18- Improving the attractiveness of the neighborhood by creating living spaces and encounters for all city residents 19- Avoid forced displacement and improving infrastructure for transport modes with low environmental impact (public transport, 2 wheels and feet to walk ...)
Does the project strengthens social ties?	5- Improve social life	20- Strengthening social cohesion and participation 21- Enhancing solidarity and social capital networks

5.3. Actual Diagnosis or Analysis

The objective of the shared SD diagnosis is to provide insights and information about the neighborhood to define strategies or action plans for a better integration of SD objectives into the neighborhood. It is not a question of evaluating all the public policies (municipal and partners) but of proposing an analysis on how the district meets the 5 global objectives of sustainable development as well as with each of the 21 targets and under -targets. The approach is therefore, by definition, transversal to all sectors and services in the city.

The HQDIL method of shared sustainable development diagnosis can therefore be represented as follows in Figure 2.

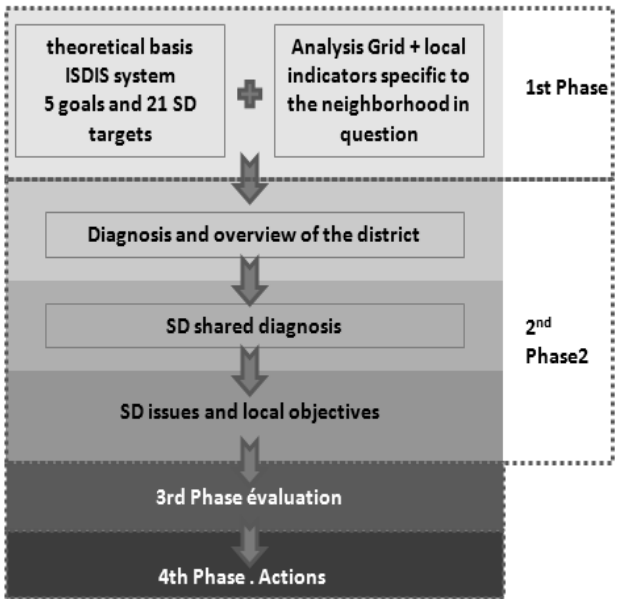

Figure 2. Shared diagnosis method, adopted for the Ruisseau/Abattoirs district

6. PRIORITIZATION OF LOCAL SUSTAINABLE DEVELOPMENT GOALS

Once this phase of diagnosis has been completed, once the development stakes have been identified for the neighborhood, it is then possible to determine or define the local objectives (neighborhood-specific).

This stage is also conducted in partnership with the various stakeholders (residents, elected representatives, municipal services, consultants, government departments, local entrepreneurs or economic actors, etc.) [29] by crossing the 5 objectives and the different targets of sustainable development. This definition of development issues will permit to define priorities and therefore the actions to be implemented for the neighborhood [30], whether in the short, medium or long term.

This prioritization can be based on the results obtained with the INDI model (indicators impact), which makes it possible to analyze different scenarios or potential action plans and their cross-impacts for the district as for other areas of the city.

6.1. INDI (indicators impact) Evaluation Model

The INDI model is an assessment tool based on the existing context and the possible evolution of the territory in case of which the project is absent.

It is based on a system of representative indicators that aim to meet the objectives of a neighborhood's sustainable development. INDI includes 61 indicators. This number of indicators appears as a compromise between a detailed description of the neighborhood and the project and an ability to constitute a tool for decision support that is also a tool for dialogue or consultation. This model is used to complete the HQDIL diagnosis and to allow a graphic representation of the quality of life in the neighborhood as Figure 3. It also serves as a support for discussions with the various actors (including the inhabitants) before the final validation of the diagnosis of the neighborhood, which becomes a shared diagnosis.

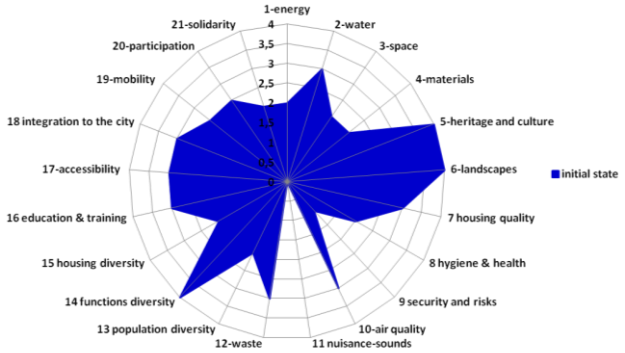

Figure 3. Ruisseau/Abattoirs neighborhood's profile in Algiers

This model is also used for evaluating neighborhoods or urban projects or for assessing the impact of the project (or of a potential project, or even several scenarios) on an existing neighborhood or territory.

The objective of the INDI model is to help the project owner to make an environmental assessment for all the project steps by integrating criteria and objectives of SD. The analysis can be conducted in several stages:

• The first step is to create a description of the neighborhood that assists in its analysis from the perspective of sustainable development (for example in the context of a shared diagnosis of sustainable development),

• The second step aims to analyze the impact of the urban project (s) on the evolution of the neighborhood.

Thus, the model evaluates the contribution of the project to the expected neighborhood improvement. The evolution of the neighborhood is analyzed through the 21 targets and the 5 sustainable development objectives of the EHQ2R approach, which means that we are not only interested in the intrinsic evolution of the neighborhood but also in neighborhood relations with the rest of the city and the agglomeration, even with the global aspects of sustainable development.

The sustainable development indicators show the evolution of the territory with regard to the 5 objectives and 21 sustainable development targets (comparison between the year *n* and the year *n*+2 or 3 for example) and allow to identify the actions.

7. RESULTS OBTAINED WITH THE INDI MODEL FOR RUISSEAU/ABATOIRS NEIGHBORHOOD

7.1. Neighborhood Environmental Profile According to Five Goals and 21 SD Targets of the ISDIS

INDI allows to create the profile of the district or the territory in terms of sustainable development at time *t* (inventory or initial diagnosis), but also at time *t*+1, once the project is in place. This analysis can be done ex ante when choosing a project but also during an evaluation of the project, once it has been implemented.

7.2. Expected Profile or Earnings of One or More (Potential) Urban Projects for Each of Sustainable Development Goals and Targets

The INDI model is based on a comparative approach that allows a prospective vision of the project as Figures 4 and 5. The analysis of the urban project (graph below on the earnings or improvements expected for the district through to the brownfield regeneration project for each of the 21 SD targets) allows to evaluate the expected changes for neighborhood buildings (improvements or possible deterioration) as for the development of the neighborhood, but also in terms of sustainable development principles.

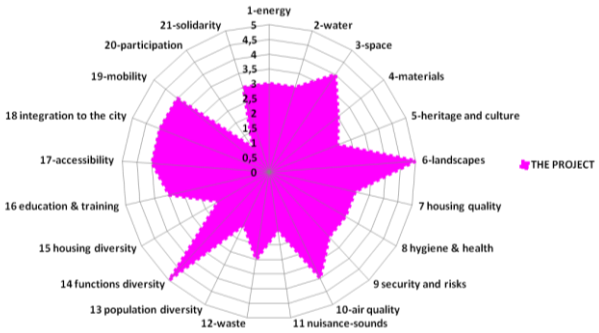

Figure 4. The project profile under 21 SD targets using ISDIS

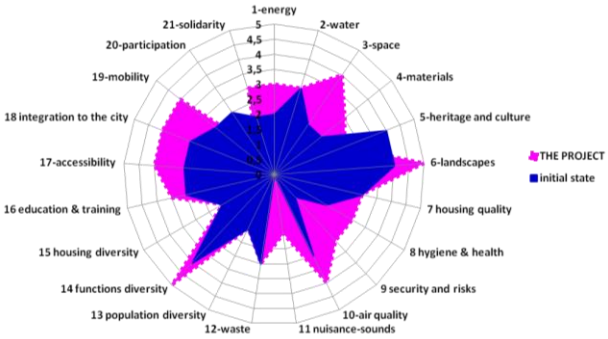

Figure 5. Analysis of the urban regeneration project under 21 SD targets showing the expected improvements compared to the initial state of the district, using ISDIS (author)

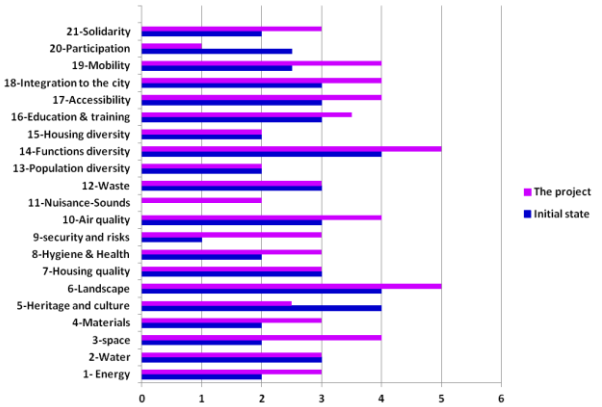

Figure 6. Prospective vision of the neighborhood, expected changes and project impact

This dynamic and prospective analysis allows the client to orient his choice between different projects (by comparing the different profiles) but also to improve a project (by identifying the targets insufficiently treated by the project). The graphs below illustrate the results obtained using the INDI model.

On the graphic radar below, the dotted lines correspond to the expected impacts of a regeneration project for the

Ruisseau neighborhood as Figure 6. Different representations can appear on a graph to help decision-makers choose one project over another or to improve a project. The expected gains or benefits from the analyzed project are provided in Figure 7.

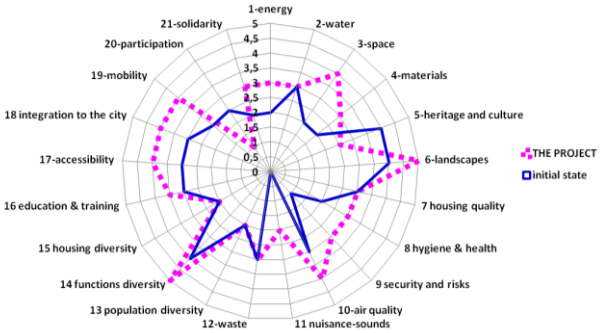

Figure 7. Analysis of the urban regeneration project (in its territory), according to the 21 SD targets, showing the expected improvements through to the project

For each of the targets, these being prioritized in order to highlight both the most positive impacts and the possible negative impacts (a negative impacts are expected for: heritage and culture target because of the difficulties that the project will cause by the demolition of an ancient industrial and historical buildings.

8. COMPARISON AND LIMITATIONS OF SIMILAR EVALUATIVE APPROACHES FOR INTEGRATION OF BROWNFIELD REGENERATION PROJECTS BRP

Similar evaluative approaches have been used by many organizations and include evaluation programs at different intervention scales, they are lacking particularly wealth in the use of indicators, as they do not cover all the sustainability dimensions [31]. Assessment methods for brownfield regeneration projects are still needed, as most tools are not able to measure their effectiveness, and in particular taking into account both the sustainability goals and the expectations of the local community [32] (Cappai et al, 2019).

8.1. Elected Similar Environmental Assessment Systems

For this selection, only the environmental rating systems performing at the urban-architectural scale projects were taken in account. Moreover, among all the rating systems available in the world, only those that meet the following four criteria were considered in this analysis:
a. Special emphasis on buildings and neighbourhoods (urban-architectural scale);
b. Scientific interest: cited in at least 30 articles on the Scopus database of Elsevier; the research was done on the basis of article titles, abstracts and keywords.
c. Widespread adoption of the system: more than 600 certified projects;
d. Duration of system implementation: more than 10 years of service.

We can summarize this whole analysis in the figure shown below, or only six evaluation systems were selected and met all the criteria that we put as upstream conditions; these systems are:

- LEED: Leadership in Energy and Environmental Design
- SBTool: Sustainable Building Too
- DGNB: Deutsche Gesellschaft fur Nachhaltiges Bauen
- CASBEE: Comprehensive Assessment System for Built Environment Efficiency
- ISDIS: Integrated Sustainable development Indicators System
- BREEAM: Building Research Establishment Environmental Assessment Methodology

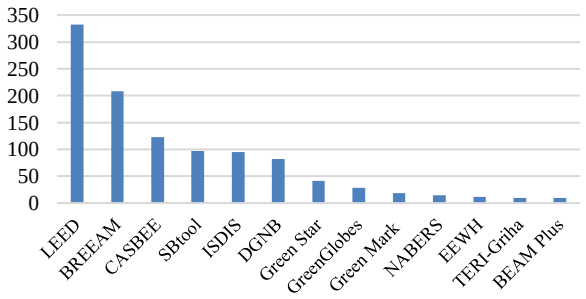

Figure 8. Number of citations of assessment systems in Scopus (Author)

8.1. Adequacy of Similar Assessment Systems Selected for Consideration of BRP

We have assessed the effectiveness of the six selected similar systems for the consideration of BRP: brownfields regeneration projects, to be done, the systems will be put under a quantitative and qualitative critical analysis based on a structured decomposition of all the criteria and indicators of each system, following four criteria of evaluation to include:
- The use of the word 'Brownfield' in assessment systems' presentation documents and catalogues (Figure 8).
- The existence of brownfield criteria or indicators.
- Relevance of the content of the criterion or indicator dealing with brownfields.
- Operational aspect of the BRP indicator

The analysis has shown also that the ISDIS system remains the most comprehensive for integration of sustainability indicators and consideration of BRP as Table 3.

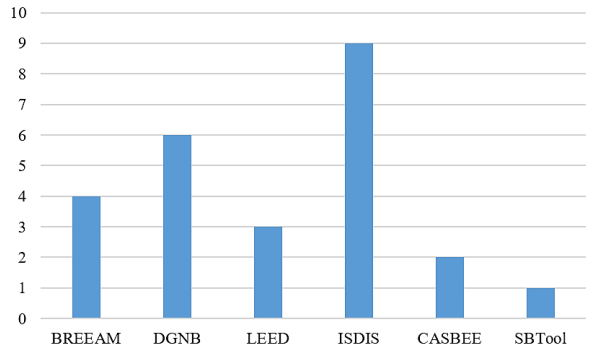

Figure 9. The use of of word 'brownfield' by similar environmental assessment systems to ISDIS (authors)

Table 3. Adequacy of the similar assessment systems to ISDIS, selected for the consideration of BRP (Author)

Assessment systems	Criteria for comparison analysis and evaluation: The use of the Word Brownfield	Criterion/Indicator In relation to the BRP	Relevance of the criteria/indicators	Operational aspects for the BRP	General assessment and suitability for taking into account BRP
BREEAM	🟢	🟢	🟡	🔴	🔴
DGNB	🟢	🟢	🟡	🔴	🔴
LEED	🟢	🟢	🟡	🔴	🔴
ISDIS	🟢	🟢	🟢	🟢	🟢
CASBEE	🟡	🟢	🔴	🔴	🔴
SBTool	🟡	🟢	🔴	🔴	🔴

Suitable for taking into account BRP 🟢
Partially suitable 🟡
Non suitable 🔴

9. CONCLUSION

For SD integration upstream, in progress, and downstream in the urban brownfields regeneration projects cities are not sustainable but can contribute to sustainability. The environmental assessment of brownfields regeneration projects is an approach that contributes to sustainable regional development. The fact to question the appropriateness of management decisions upstream the projects can prevent and reduce environmental impacts. The environmental assessment looks at all potential or management decisions concerning the territory, and therefore the sum of their environmental impact, unlike the impact assessment that will analyze each project individually.

The aim of this contribution is to give the communities who are developing the brownfields regaining project, as well as actors and organizations that accompany them (consultants, urban planning agencies, state services ...), the elements to understand the objectives and the interests of the environmental assessment, and the keys to effectively lead this complex appearance of approach.

The analysis has shown also that the ISDIS system remains the most comprehensive for the integration of sustainability indicators and the consideration of brownfield regeneration projects at the architectural local scale. In this sense, it will be a real decision support to help local decision-makers

NOMENCLATURES

1. Acronyms

ISDIS: Integrated sustainable development indicators system
HQE: Haute Quality Environmental
SD: Sustainable Development
EHQ2R: Environmental High Quality for Rehabilitation and Regeneration
INDI: Indicators impact
HQDIL: Heritage Environmental Quality, Diversity, Integration, Social Link
LEED: Leadership in Energy and Environmental Design
SBTool: Sustainable Building Tool
DGNB: Deutsche Gesellschaft fur Nachhaltiges Bauen
CASBEE: Comprehensive Assessment System for Built Environment Efficiency.
BREEAM: Building Research Establishment Environmental Assessment Methodology

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