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URBAN REGENERATION OF LARGE HOUSING ESTATES THROUGH THE HQE²R APPROACH – CASE OF BAB EZZOUAR (ALGIERS)

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ABSTRACT

This article aims to adapt HQE²R approach to the Algerian "large housing estates", through urban regeneration as a catch-up project. These neighborhoods constitute today a large stock of housing, mostly in decay, which deserves to be renewed. Nevertheless, they remain desirable neighborhoods due to their strategic urban location. The methodology consists of establishing a shared diagnosis model of sustainable development called HQDIL for detailed description of ZHUN Soummam according to urban actors, then an SD indicators assessment model called INDI as a decision support tool for the benefit of local authorities and their partners. In our study, we opted for INDI-2012 repository as a new operational tool which makes it possible to produce sustainability profiles through 127 composite indicators and 234 secondary indicators, first of all for an initial diagnosis, then by drawing up a potential scenario which describes the contribution of the urban regeneration project to improving the quality of life. Perceived visually, the neighborhood's critical state with regard to the SD objectives was confirmed following the results of the assessment by themes, especially the indicators dealing with the quality of life of the inhabitants. The potential scenario for the urban regeneration project showed a very satisfying sustainability profile, if an action plan were to be implemented. The scenario showed a significant improvement in the neighborhood's level of sustainability of 47% compared to the initial situation. This study promises to lead to a sustainable transformation of large housing estates in Bab Ezzouar thanks to shared challenges and proactive policies.

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Glossary.

HQE²R	**H**igh **E**nvironmental **Q**uality, **E**conomy, neighborhood **R**egeneration, **R**ehabilitation of buildings
NSAT	Neighborhood Sustainability Assessment Tools
HQDIL	Legacy- Environmental quality- Diversity- Integration- Social link
INDI	**IND**icators **I**mpact
ISDIS	**I**ntegrated **S**ustainable **D**evelopment **I**ndicators **S**ystem
ZHUN	New Urban Housing Zone
SNAT	National Land Use Planning Scheme
PDAU	Master Plan for Development and Town Planning for Algiers
CES	Land acquisition coefficient
COS	Land occupancy coefficient
CSTB	Scientific and Technical Center of the Building
SD	**S**ustainable **D**evelopment
TOL	Occupancy rate per dwelling
OPGI	Office for the promotion and management of real estate
SEAAL	Water and Sanitation Society of Algiers
SONELGAZ	National Electricity and Gas Corporation
SUDEN	**S**ustainable **U**rban **D**evelopment **E**uropean Association
ZAC	Concerted Development Zone

1. Introduction.

Joining the Club of Performing Metropolises is the major concern of emerging cities. These urban agglomerations appear now as veritable laboratories for new practices and strategies, which tend to mobilize national resources in order to successfully integrate them into international urban competition. This is why Algiers seeks, in a context of globalization and competitiveness, to take position in the Top-Five of the Mediterranean metropolises of tomorrow. (SNAT, 2010)

The metropolization process underway in Algiers, requires new forms of urban territory organization, and needs imperatively a sustainable development strategy to properly control the risks of resource depletion, significant degradation of the urban environment and loss of social cohesion. In recent decades, the large housing estates in Algiers have suffered from significant deterioration in terms of the urban environment, hence the urgent need to use operational tools to remedy urban dysfunctions.

1.1. Large housing estates, from genesis to loss of urbanity.

The genesis of the large Algerian housing estates goes back to colonial times, precisely the Constantine Plan 1958. The colonial French authorities tried to spread this emblematic post-war model, designed to solve a growing housing crisis, throughout the territory of Algeria's largest cities. Despite its embodiment of a sought-after new modernity, the typology of this model was not initially appreciated by local populations, who were used to living in individual houses. But the need to house as many Algerians as possible who are huddled in shantytowns or driven out of their destroyed villages ended up with them being grouped together in these peripheral towns on the fringes of European society (ethno-racial social segregation).

Since Algeria's independence in 1962 to the present day, the state continues to build large housing estates. The succession of different programs has led to the development of several types of collective habitat under different formulas (social, participatory, rental, assisted), but retaining the old functional aspect of large housing estates (as crowded neighborhoods on the outskirts of cities). After 70 years of their appearance in Algeria, these neighborhoods seem to be socially and culturally appropriate for the inhabitants.

The ZHUN, as social housing, are considered to be the second generation of large housing estates. Issued by the circular of 19 February 1975 on the creation of new urban housing zones, the ZHUN model is carried out on 257 sites giving rise to approximately 670.000 collective dwellings (Nait Saada, 2010). Most of these neighborhoods appear to be relegated urban areas. Their potential lies in the fact that they have been overtaken by urbanization, and they are now in the pericentral urban crown. However, the highly degraded state of these settlements combines the inability of local authorities to find the necessary operational tools, to prepare a catch-up project adopting the founding principles of SD.

1.2. What catch-up tools for large housing estates?

In Europe, urban policy for the regeneration of large housing estates focuses mainly on the challenge of creating a social mix (Roudil, 2023). These outlying neighborhoods are now mostly deserted. While in Algeria, urban degradation in large housing estates is acutely affecting two dimensions; environmental quality and social life. These dimensions are a major challenge for urban actors in search of an ideal model wherever it will be pleasant to live.

The United Nations (2017) published:

> *"…Cities and human settlements must fulfill their social and ecological function of land, with a view to progressively achieving the full realization of the right to adequate housing as a component of the right to an adequate standard of living…, universal access to safe and affordable drinking water and sanitation, as well as equal access for all to public goods and quality services in areas such as food security and nutrition, health, education, infrastructure, mobility and transportation, energy, air quality and livelihoods"* (P.05)

The HQE²R method is a systemic and transversal approach. Its scope is defined in the SD objectives to which the neighborhood should respond. The method is structured according to analytical tools and grids that define qualitative and quantitative indicators of SD that can be measured at the neighborhood scale. The operational tools of HQE²R allow first to prepare a shared diagnosis through the HQDIL tool, but also to evaluate a new urban development or regeneration project using the INDI tool.

The value of this study is demonstrated by the need to adapt a decision support tool for the ongoing transformation of large housing estates, seeking to concretize Algerian urban policy with regard to sustainable development, as a tool for operational analysis and intervention on a neighborhood scale.

After analyzing the literature review of previous studies, all articles (Dahmani 2015; Sehili, Chennaoui, and Madani 2016; Chaguetmi and Derradji 2019; Roula and Bouchair 2021) focused on the "INDI-2005" model of the HQE²R approach and its "ISDIS system" for assessing the sustainability of an urbanized sector. This system is structured under 21 targets and 73 indicators to measure the sustainability of a neighborhood. The purpose of this study is to explore a new tool (Table 1), that represents the extended version of the old INDI-2005 model, bearing the acronym "*INDI Millésime 2012*" in reference to its year of creation (Charlot-Valdieu and Outrequin, 2012).

According to Chaguetmi's (2019) study, "HQE²R as an approach is simply the most adapted, integrated and reliable method for neighborhood SD assessment" (P.4566). It is positioned as a structured approach based on objectives. Sehili, Chennaoui, and Madani (2016) have drawn up an assessment of an old historic center through HQDIL, shedding light on its state of degradation and identifying challenges to revitalize it. Research by Dahmani and Adad (2015) replicated the HQE²R approach on a new neighborhood within the framework of the urban project, while conceiving two scenarios of "low versus high performance". Roula and Bouchair (2021) applied the INDI-2005 model to assess the sustainability of coastal district as mixed urban area, and to determine the contribution of the Land Use Plan as development project of this urban zone.

Table 1. Comparative study between INDI-2005 and INDI-2012 tools.

Tool / Criteria	**INDI-2005**	**INDI-2012**
Typology	Model	Repository
Structure	21 Targets, 73 Indicators	04 key issues, 20 Themes, 127 Indicators, 257 Secondary Indicators
Assessment method	System for weighting and aggregating indicators	System for weighting and aggregating indicators
Scale	Neighborhood, City	Neighborhood, City
Fields of application	Urban project Urban regeneration	Urban project, Development of an Eco-neighborhood, Urban regeneration
Type of use	Decision, Follow-up, Assessment, communication	Decision, Follow-up, Assessment, communication
Type of association	Integrated HQE²R tool	Integrated, Dissociable HQE²R tool
Evolutionary	No	Yes
Barometer of sustainability	out of 10	out of 5
Level of completeness considering SD objectives	●●	●●●

Why choose INDI-2012? (Authors, 2024).

In Algeria, the SNAT-2030 has drawn up Territorial Action Programs called “PAT” aimed at:

- PAT N°12: upgrading and modernization of the major cities "Algiers";
- PAT N°18: renewing city policy through urban regeneration, the rehabilitation of large housing estates and the eradication of precarious housing (SNAT, 2010, P.82)

These territorial action programs have remained guidelines for the preparation of planning and urban development instruments, but they have not been able to translate operational action plans at city or neighborhood scale.

In that respect, the competent authorities need an operational tool for reading, analyzing and evaluating the socio-urban framework of urban entities. A tool that is reliable, comprehensive and quick to execute. So how can we measure and evaluate the sustainability of this type of neighborhood and what its future might be based on an urban regeneration project scenario?

Through this article, the HQE²R Method will provide answers to this fundamental problem, which is constantly growing at the level of this type of changing neighborhood. The objective is not to look for a "whole renewed", but to ensure both the collegial power of shared decision-making and the citizen monitoring in search of a decent and appropriate urban living environment.

2. Materials and Methods.

For more than two decades, researchers have been trying to find the best operational tools to achieve SD goals at the neighborhood level. Dawodu, Cheshmehzangi, Sharifi and Oladejo, (2022) show that the HQE²R method is a pioneer among many other Neighborhood Sustainability Assessment Tools NSAT, but since it is a method published mostly in French, it has not benefited from a large readership and consequently from scientific publications.

Designed for the French context by Charlot-Valdieu C. (CSTB) and Outrequin Ph. (La Calade) within the framework of European project SUDEN, HQE²R is a method of integrating SD and assessing its contribution to new planning projects or urban regeneration at the building and neighborhood level. For urban regeneration, it aims at a sustainable transformation of existing, marginalized, degraded and

distressed neighborhoods. HQE²R can be used by all urban actors (local authorities, partners, organizations and users) to diagnose, measure and communicate information about the neighborhood to be studied. Theoretically, the methodological approach of a project is based on four phases: decision, analysis, design-assessment, action-implementation (Figure 1).

The HQE²R method is also based on six SD principles stemming from the 28 principles of the 1992 Rio Conference (economic efficiency, social equity, environmental efficiency, long-term, global, governance), and five global objectives (heritage and resources, local environment, diversity, integration, social link).

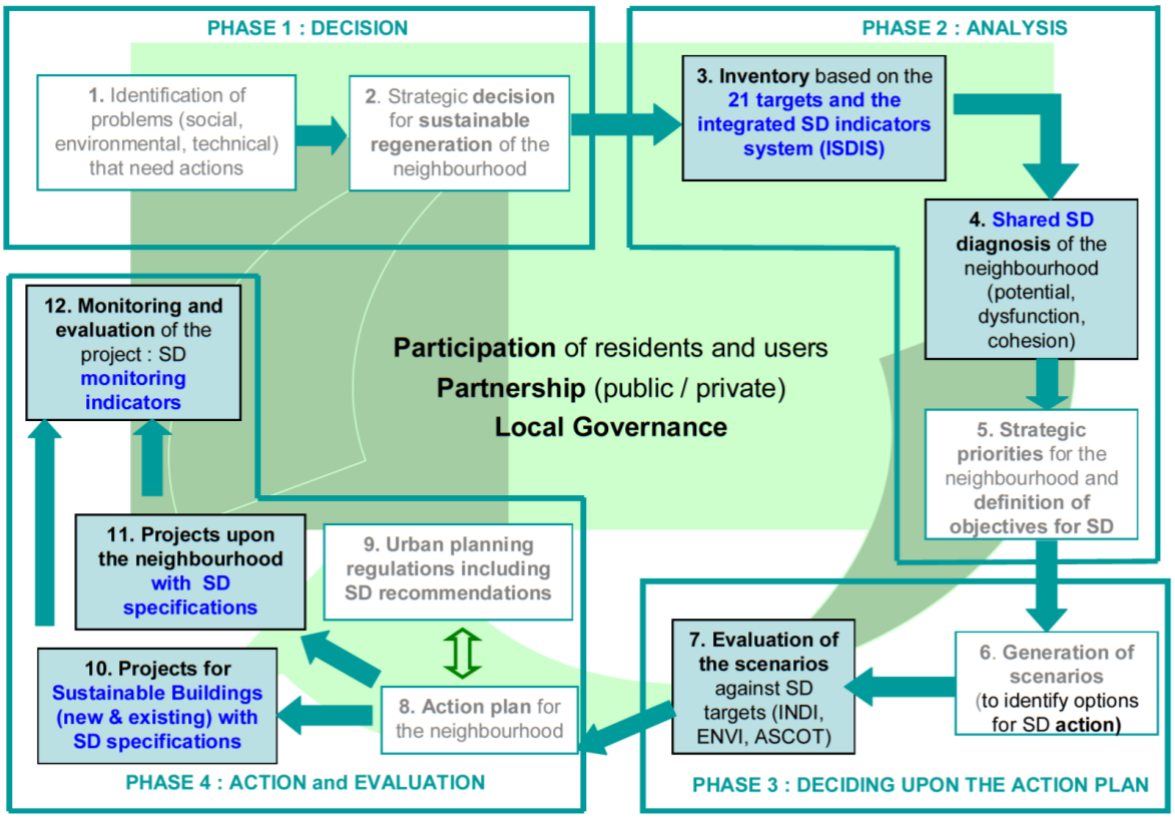

Figure 1. HQE²R approach toward sustainable neighborhood development. (Source: Charlot-Valdieu and Outrequin, 2004).

The shared diagnosis method of SD is carried out through the HQDIL tool. It is based on a grid for evaluating the components of a neighborhood (residential spaces, non-residential spaces, unbuilt spaces, infrastructures and networks). This tool is recommended for preliminary studies of urban planning instruments, new development projects or urban regeneration of existing neighborhoods (Charlot-Valdieu and Outrequin, 2004).

The second tool of the HQE²R approach is INDI. It was originally designed for urban regeneration projects. It is a multi-scale tool that has been developed many times by its initiators in the context of European research projects, so that it can be applied to projects of all kinds (Charlot-Valdieu and Outrequin, 2012). It is also valid for application to the scale of one-off operations (Buildings or exterior landscaping).

As far as adaptability is concerned, it is possible to apply HQE²R in the Algerian context, given the similarity between urban policy and the legislation governing urban production in the two countries (France and Algeria). The use of this approach, in contrast to recurrent theoretical tools, may help to establish a new more tangible and effective operational approach and this in order to make the SD objectives a reality at the neighborhood. (Figure 2).

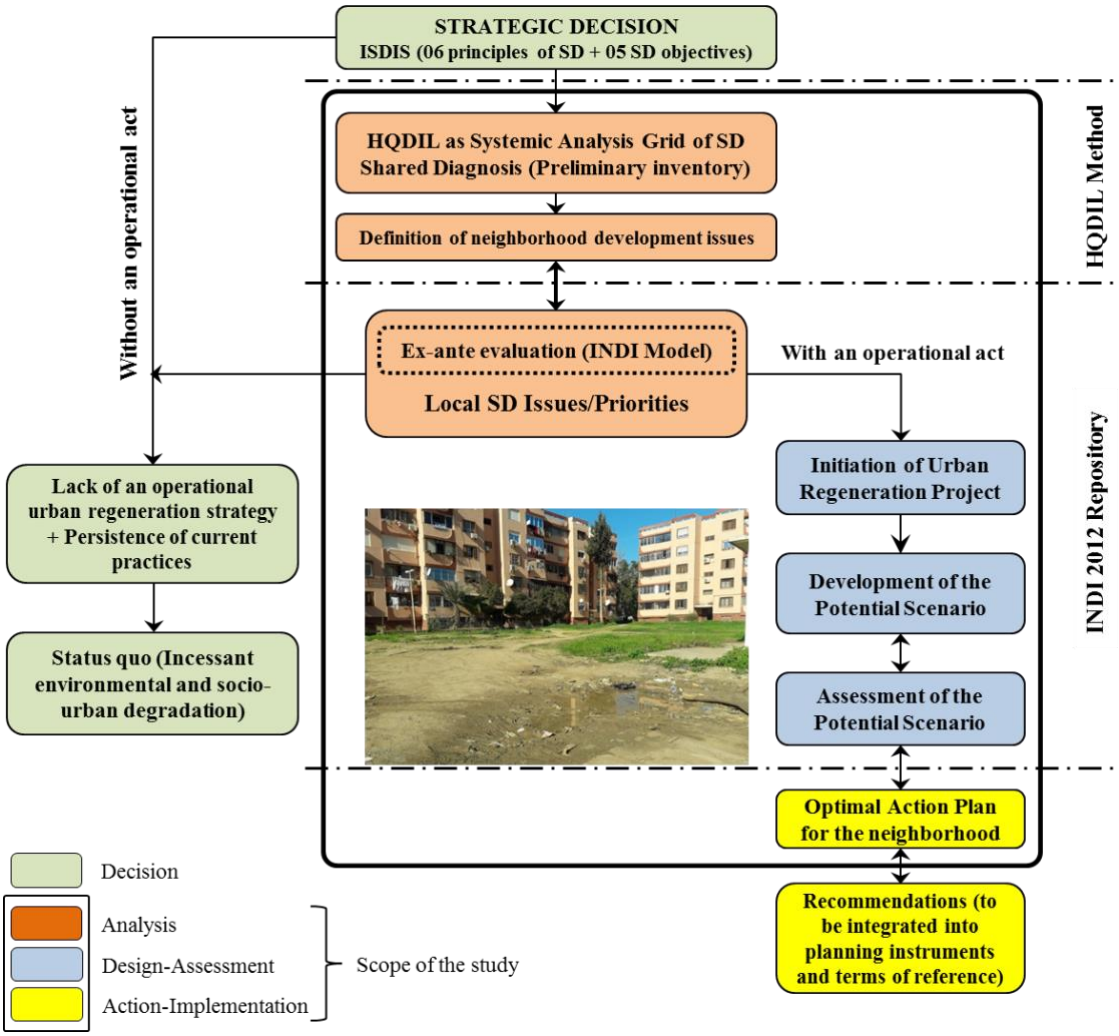

Figure 2. Methodological process for the study of shared diagnosis and assessment of proposed scenario for the ZHUN Soummam using HQE²R tools (Authors, 2023).

Given the complexity of the neighborhood scale and the difficulty of identifying all its components, reading and analysis require a significant number of parameters to assess. The INDI-2012 repository is designed to meet this fundamental need of urban actors, who often seek to clearly define the socio-economic and environmental concerns of the inhabitants, with the aim of creating human settlements with an impeccable quality of life. The variety of indicators and their accuracy according to a benchmarking system make it possible to accurately diagnose the shortcomings and weaknesses that affect the quality of life in neighborhoods.

In this article, INDI-2012 is treated as an integrated repository where we contextualize it with national and local issues dictated by Algerian urban planning documents. Although it follows the original structure of the repository, the system of aggregation and weighting of themes depends on the orientations of local authorities and the concerns of inhabitants. INDI-2012 is structured according to a branched system that draws the tree diagram of the hierarchy of its components (figure 3). It is defined in a set of four (04) main issues, which themselves break down into sub-issues, and then into twenty (20) themes. These themes determine the neighborhood's level of sustainability through the subsystem of 127 composite indicators (synthetic), whose measures depend on a subset of 234 secondary indicators.

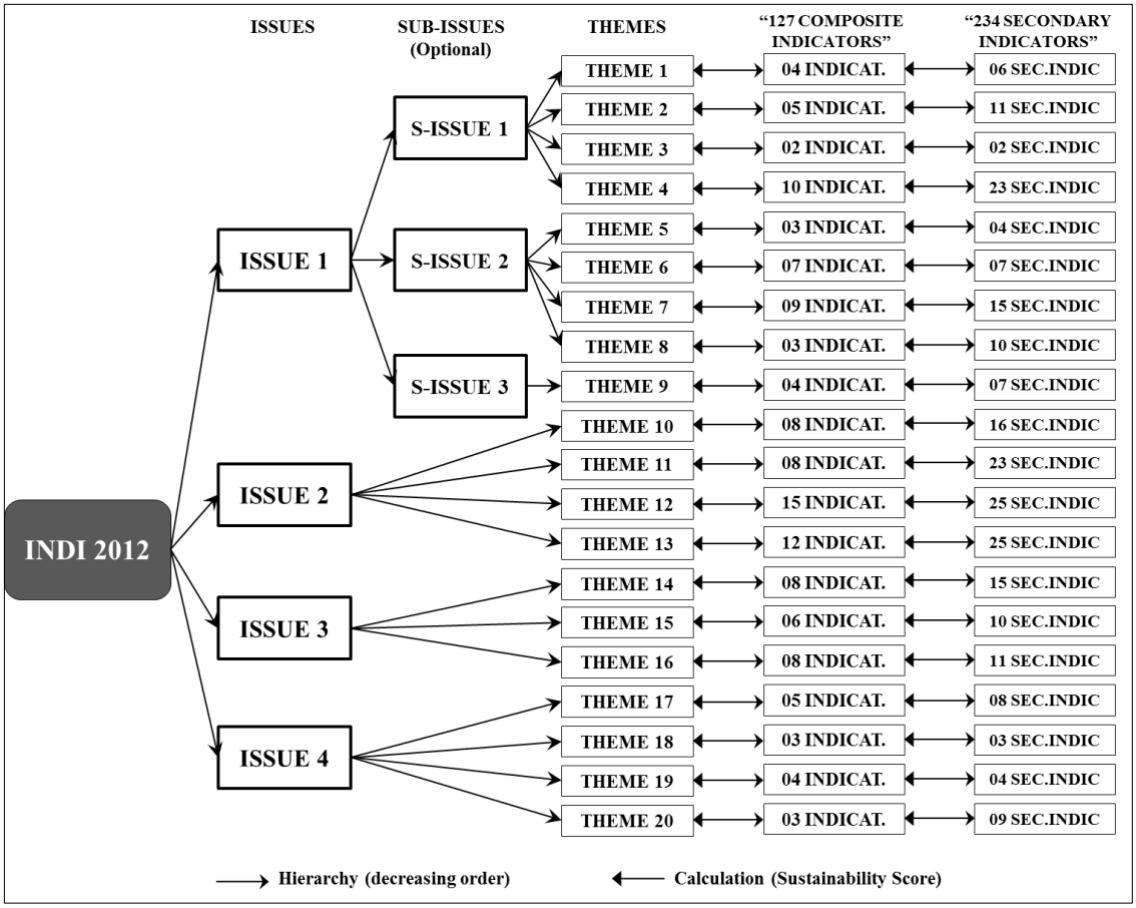

Figure 3. Tree diagram of INDI-2012 model defining hierarchy and calculation mode (Authors, 2022).

In view of the neighborhood's difficult situation, our study focused only on the INDI-2012 model indicators that deal with the urban regeneration process (in this case 125/127 composite indicators and 230/234 secondary indicators).

The evaluation process is carried out in iterative stages, through survey, data collection and in situ measurements. Some indicators are measured using technical instruments (luxmeter, sound level meter,..), or through the data collection (specific collected studies from SONELGAZ, SEAAL, sanitation office, police station, Sama El-Djazair, …). The remaining indicators were assessed through the on-site survey (survey for local authorities, services, residents and users on themes relating to architecture, transport, energy, drinking water, sanitation, green and public spaces, nuisances and associative work, carried out in 2022).

The calculation method is based on an accessible and free application entitled "*INDI Millésime 2012*" developed on the 2010 Microsoft Excel VBA. This version of the application is available as an Excel file (.xlsm) on a CD-Rom attached to the book (Charlot-Valdieu and Outrequin, 2012), valid for any type of urban planning and regeneration project. The assessment process through the application is composed of three successive steps:

- Inform (identification of the nature of the project and the type of entry desired)
- Evaluate (describe the indicator and method of measurement, then assign a score)
- Synthesize (preparing tables and charts from the results of calculations).

The system for evaluating quantitative and qualitative indicators is subject to a scoring grid based on predefined benchmarks. Threshold values and targets justify the sustainability score to be assigned to each indicator based on the results obtained (investigation, data collection, in situ measurements). The aggregation of secondary indicators, followed by composite indicators, defines the score for each theme of INDI-2012. The scoring of the 20 INDI themes is developed from the barometer of sustainability (Prescott-Allen, 1997) that ranges from 0 to 5 (Table 2).

Table 2. Comparative table of sustainability barometer scales (Authors, 2024).

Sustainability barometer scale (Prescott-Allen, 1997)		Sustainability barometer scale (INDI-2012 Repository)	
Score	Qualifier	Score	Qualifier
0	-	0	Unsustainable
1 – 20%	Bad	0.1 – 1	Almost unsustainable
21 – 40%	Mediocre	1.1 – 2	Slightly sustainable
41 – 60%	Medium	2.1 – 3	Moderately sustainable
61 – 80%	Satisfying	3.1 – 4	Almost sustainable
81 – 100%	Good	4.1 – 5	Sustainable

In addition to assessing the neighborhood's state of play in terms of sustainability, INDI makes it possible to focus on themes with zero to low ratings. This repository allows for an anticipatory scenario called a "normative scenario" (Julien, Lamonde and Latouche, 1975). The latter represents a forward-looking scenario that aims to project an image of a possible and desirable future that is being sought for the neighborhood. First, the objectives to be achieved for an urban regeneration project are clearly identified. Subsequently, INDI harnesses the strengths and opportunities of the neighborhood to improve the performance of the themes. Finally, the scenario becomes possible by referring to the benchmark values of the indicators.

2.1. Case Study.

Built in the 1970s and located on the southern outskirts of Algiers, large collective housing estates are today the type with the largest number of dwellings in the housing stock in Bab Ezzouar (ONS, 2008). We have chosen to develop our study on ZHUN Soummam as a representative sample for the following arguments:

- Its strategic location adjacent to National Road No.5 and the Northern Bypass of Algiers, as well as its median position between the collective housing districts;
- Its date of construction between the first and third generations of the Algiers ZHUN;
- Its large area and population make it ideal for analysis and result extrapolation;
- The possibility of access to sensitive data in order to carry out the investigation and the necessary in situ measurements;
- The existence of significant potential for transformation and positive contamination (the neighborhood will be the catalyst for urban regeneration policy);
- It has never benefited from restructuring and/or renovation works. This allows us to properly identify the problems and gives us the legitimacy to make a realistic judgment on the large housing estates in Bab Ezzouar.

The situation of ZHUN Soummam is characterised by the presence of a heteroclite urban tissue of varied typology (Figure 4). The district is bounded to the north by national road N°5 and the city of Douzi-4, to the east by the 5-July Park, to the south by the University City CUB3 and the ZHUN 5-July, and to the west by the nursery and a high voltage easement.

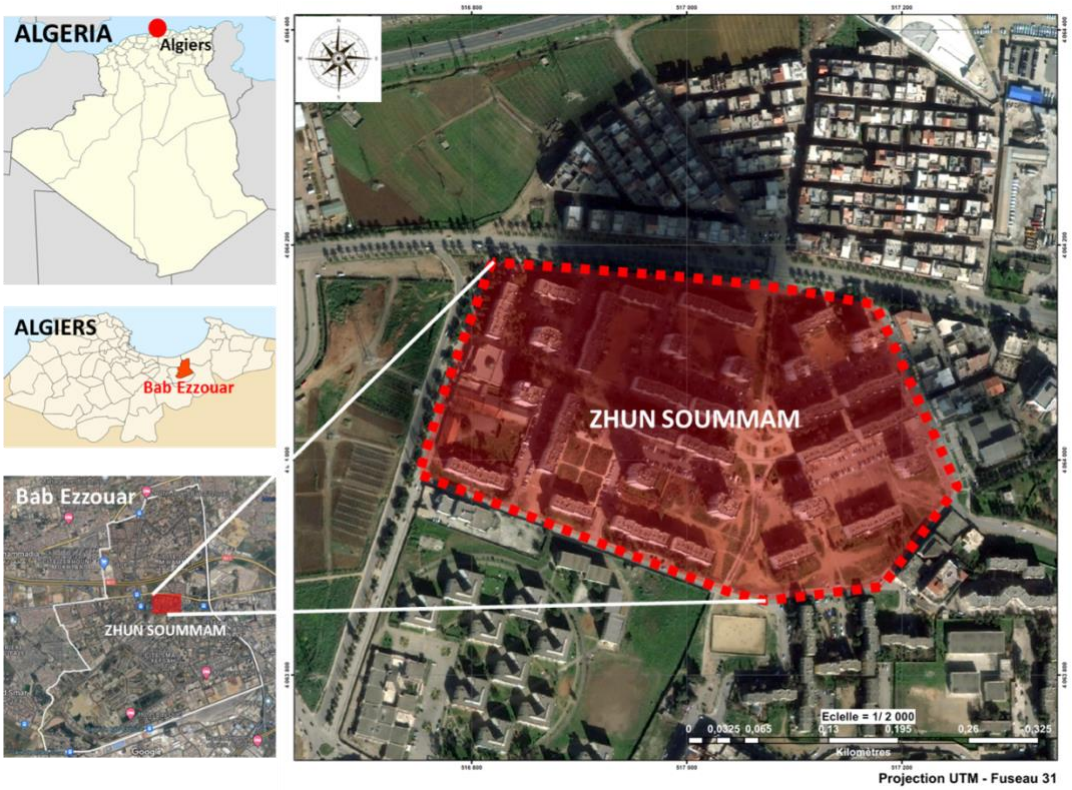

Figure 4. Urban location and boundaries of the ZHUN Soummam. (Authors, 2023).

A visual reading of the situation reveals the advanced deterioration of the image and quality of life of the neighborhood. First, the phenomenon of overcrowding is due not only to a high TOL but also to the informal occupation of the crawl spaces of buildings through their transformation into precarious housing.

The ZHUN Soummam lacks properly developed community and intergenerational spaces (green and public spaces). Between the buildings, there are interstitial spaces or no-man's land strewn with household waste, facades damaged by traces of moisture and seepage (Figure 5).

The neighborhood is desperately short of support facilities and community services. Roads leading to building entrances are impassable and unpaved.

Figure 5. Degradation of the urban environment of the ZHUN Soummam. (Authors, 2023).

3. Results and discussion.

First, shared diagnosis as a participatory approach, integrates the notion of governance at the neighborhood scale. The diagnosis should involve, among others, local communities, users and residents. It explains the neighborhood's situation vis-à-vis SD objectives in order to propose an intervention strategy (Charlot-Valdieu and Outrequin, 2007).

Not all neighborhood sustainability goals are equally important. Priority issues are easily identifiable following HQDIL's shared diagnosis of sustainable development. The goal is to identify local SD issues that could improve the quality of life.

According to the survey of 10% of the resident population, the neighborhood clearly suffers from urban deficiencies and dysfunctions, which mainly affect the components of the urban environment (residential space, non-residential space, unbuilt spaces, roads and various networks) (Table 3).

The interpretation of the results confirms the pre-established reading of urban reality, and guides the unanimous decision on the choice of prioritization of the SD objectives to be achieved for the neighborhood. These local objectives call for the INDI model for a detailed analysis of the indicators to be improved.

Table 3. Shared diagnosis approach of sustainable development HQDIL of the ZHUN Soummam (Authors, 2022).

	Structure	**Use**
Residential built space	▪ Area (11 hectares); ▪ 1000 social housing units, 92 precarious housing in crawl spaces; ▪ Gross density: 91 dwellings/ha. ▪ Typology of buildings (85 % bars, 15 % towers); ▪ Gauge: 4 to 5 storeys (Bar) / 10 storeys (Tower); ▪ CES (0.16) / COS (0.71); ▪ Typology of dwellings: 10% (1-bedroom apartment), 55% (2-bed.Apart), 30% (3-bed.Apart), 5% (4-bed); ▪ Poor Building conditions (carbonation of concrete, water tightness, elevators, crawl space, Trash Chute).	▪ 5500 inhabitants, >50% of population is young (18 to 45 years old); ▪ >70% of employed population; ▪ Population density 520 inhabitants/ha. ▪ Overcrowded housing: TOL (5.66); ▪ 99.8% of dwellings are occupied; ▪ 77.2% of inhabitants are owner-occupiers (22.8% are tenants); ▪ Poor ventilation (Musty smells); ▪ Low thermal insulation (No indoor thermal comfort + High energy consumption).
Non-residential built space	• Few of public facilities: mosque, sports hall, printing plant, administrative services for the management of drinking water and energy, occupying the ground floor of a residential building (OPGI, SEAAL and SONELGAZ) • Average yield of trade and service activity: community shops, support services (doctor's offices, dentists, nail salon, civil foundation). • With the exception of the mosque and administrative facilities, shops and services on the ground floors of residential buildings are in poor condition (70%).	• Unbalanced distribution of public facilities shops and services; • Lack of public facilities (market, health care center, pitch, gym, youth center, children's garden)*; • Lack of integration and urban cohesion: residents must move to adjacent districts to access public facilities.
Unbuilt space	• Lack of structuring of unbuilt spaces; • Lack of separate boundaries and functional hierarchy between public and private spaces; • Deficit in terms of landscaped urban green spaces reserved for inhabitants (5.7 m²/inhabit.); • Absence of children's play areas; • Lack of bike lanes and deficiency of waste collection points.	• Free public spaces as "no man's land"; • Unbuilt spaces are dirty and unhealthy; • Lack of maintenance of public spaces; • The drainage system is defective; • Lack of security at night (delinquency, drugs); • Positive attempts by residents through residentialization of green spaces and building entrances (gardens, urban landscape).

	Structure	Use
Residential built space	▪ Area (11 hectares); ▪ 1000 social housing units, 92 precarious housing in crawl spaces; ▪ Gross density: 91 dwellings/ha. ▪ Typology of buildings (85 % bars, 15 % towers); ▪ Gauge: 4 to 5 storeys (Bar) / 10 storeys (Tower); ▪ CES (0.16) / COS (0.71); ▪ Typology of dwellings: 10% (1-bedroom apartment), 55% (2-bed.Apart), 30% (3-bed.Apart), 5% (4-bed); ▪ Poor Building conditions (carbonation of concrete, water tightness, elevators, crawl space, Trash Chute).	▪ 5500 inhabitants, >50% of population is young (18 to 45 years old); ▪ >70% of employed population; ▪ Population density 520 inhabitants/ha. ▪ Overcrowded housing: TOL (5.66); ▪ 99.8% of dwellings are occupied; ▪ 77.2% of inhabitants are owner-occupiers (22.8% are tenants); ▪ Poor ventilation (Musty smells); ▪ Low thermal insulation (No indoor thermal comfort + High energy consumption).
Infrastructures and networks	• Three structural axes ensuring territorial and urban accessibility (North Bypass of Algiers, National Road No.5 and the road of Bab Ezzouar); • A network of internal and contiguous roads of 2.2 km general length; • Poor quality road network (presence of potholes); • A tram line at 200 m; • A train station at 1 km; • A single bus line; • Illegal connections and modifications (sewage, drinking water, electricity, gas, garbage chute system).	• A very high directional flow north of the neighborhood, along the National Road No.5. This road is a source of noise, odor pollution, insecurity, and an infrastructural urban break on the north; • Intercity bus stop nearby; • Tramway stop at 250 m; • Adequate and secure parking areas (not maintained); • Energy, water and sewage networks in poor condition (lack of upkeep).

**According to the Algerian theoretical grid of facilities*

The INDI model's adaptability and ability to be contextualized regardless of project type is one of its key strengths. The system of aggregation and weighting of this model is dependent on urban, socio-economic, environmental and political-managerial characteristics of the Algerian large housing estates. The readjustment of the INDI-2012 repository to evaluate the ZHUN Soummam requires combining the analysis themes according to a new aggregation that meets the SD goals in Algeria.

The assessment of the neighborhood's initial situation according to the 20 themes of INDI and their indicators was carried out according to an aggregation system combining the secondary indicators, then the indicators which, in a weighted average, give the final score to the theme to be calculated. The sustainability score for each of the 20 themes within this system is calculated on the basis of the weighted average according to the following formula:

$$Sustainability\ note\ of\ the\ theme = \frac{\Sigma(Indicator\ sustainability\ score \times weighting\ coefficient)}{\Sigma\ weighting\ coefficients}$$

With:

$$Indicator\ sustainability\ score = \frac{\Sigma(Secondary\ indicator\ sustainability\ score \times weighting\ coefficient)}{\Sigma\ weighting\ coefficients}$$

The results of initial diagnosis of the neighborhood's state reveal the scores obtained for each of the themes of INDI (Table 4). Sustainability score per theme are used to create the sustainability profile with regard to neighborhood's urban reality (Figures 6, 7).

Table 4. Results of the initial diagnosis of the neighborhood's sustainability through the INDI-2012 themes (Authors, 2024).

N°	INDI Themes	Score "Initial diagnosis"
1	Energy management in project design	**1,4**
2	Energy management in buildings	**0,4**
3	Light atmosphere	**2,0**
4	Travel management	**1,3**
5	Space consumption	**2,3**
6	Biodiversity	**0,1**
7	Sustainable water management	**0,7**
8	Sustainable management of materials and natural resources	**0,0**
9	Combating poverty and exclusion (employment and housing)	**0,0**
10	Accessibility to quality services and facilities	**2,2**
11	Quality of buildings, housing and private spaces	**0,8**
12	Quality of public and green spaces	**0,4**
13	Safety, risks, health and nuisance reduction	**0,2**
14	Participation in the collective effort and integration into the city	**1,4**
15	Solidarity and diversity policy	**1,4**
16	Culture, education and training	**0,6**
17	New way of thinking and acting (approaches, methods and tools)	**0,3**
18	Evaluation and capitalization as a method of learning and improvement	**0,0**
19	Partnerships	**0,0**
20	Involvement of residents and users	**0,8**

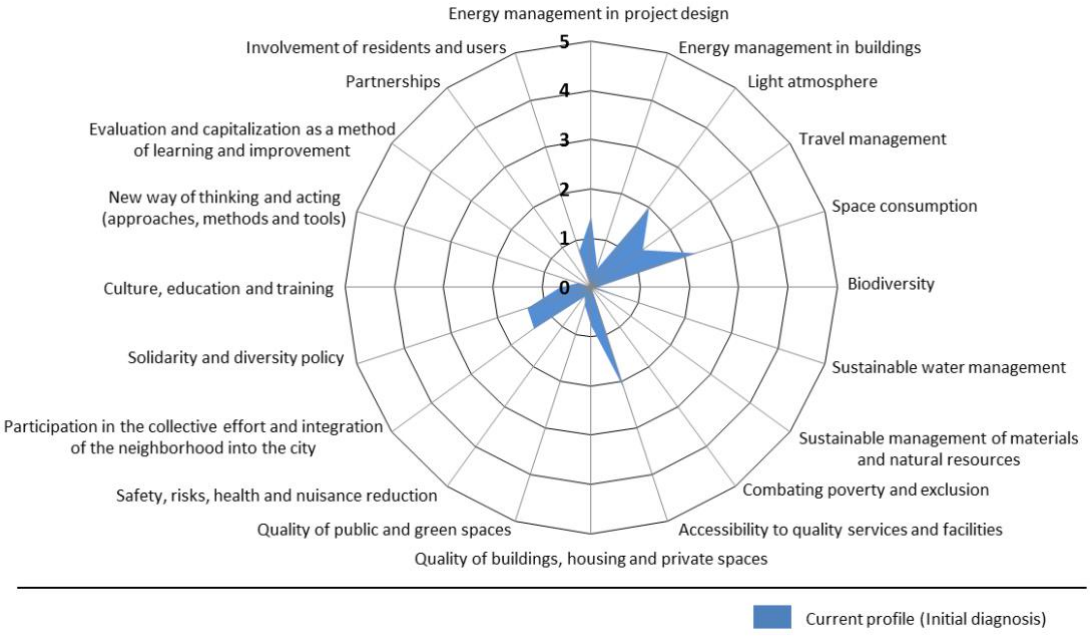

Figure 6. Radar chart representing the sustainability assessment profile of the ZHUN Soummam according to the 20 themes of INDI-2012.
(Authors, 2024).

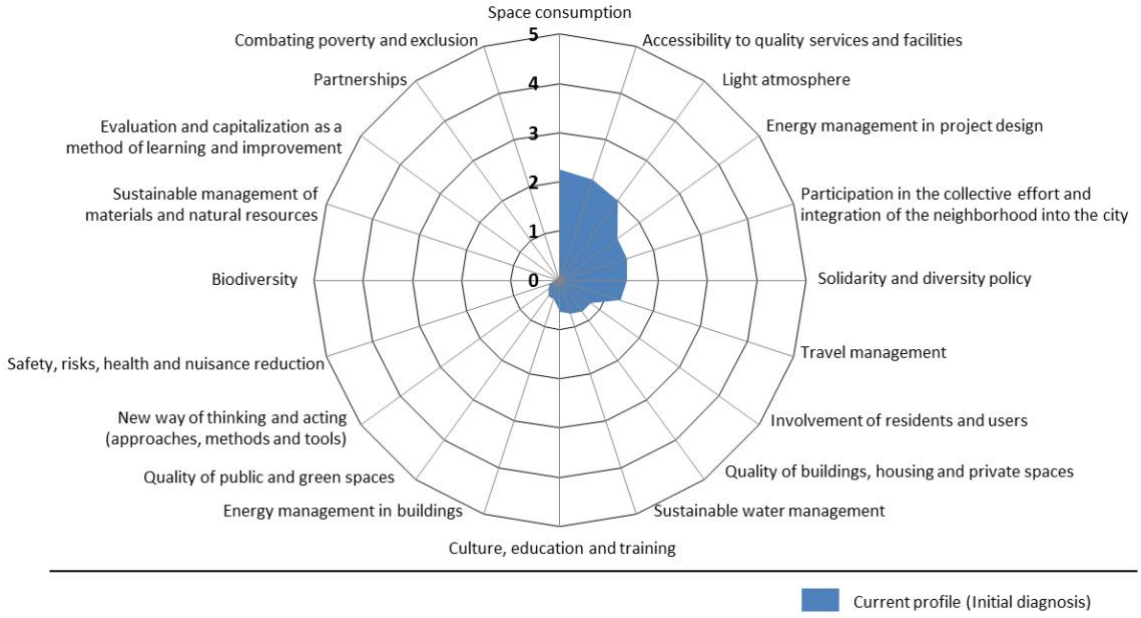

Figure 7. Spiral radar chart representing the sustainability assessment profile of the ZHUN Soummam according to the 20 themes of INDI-2012 "from best to least treated".
(Authors, 2024)

According to the results shown on the sustainability profile, themes are divided by the barometer of sustainability into four categories:

- Unsustainable (Themes 8, 9, 18 and 19): the neighborhood has an absence in terms of sustainable materials use, actions for employment and social inclusion, method of learning and improvement, but also partnerships as a form of participatory democracy. Drastic measures must be taken to remedy this situation.
- Almost unsustainable (Themes 2, 6, 7, 11, 12, 13, 16, 17 and 20): These are themes in which the neighborhood suffers dysfunctions, particularly in the fields of energy consumption, biodiversity, water supply, quality of urban environment (buildings and public spaces), cultural and educational activities and citizen participation in community life.
- Slightly sustainable (Themes 1, 3, 4, 14 and 15): There are also difficulties in overcoming the energy management in building design, quality of public lighting, traffic management, urban integration and social mix.
- Moderately sustainable (Themes 5, 10): Space consumption and accessibility to quality services and facilities, are two themes that can guide a project as beginning to kick-start the neighborhood sustainability.

The sustainability profile of the neighborhood shows not only a fairly significant degradation in terms of the urban environment, but also the presence of a management system that does not accompany global and local sustainability issues. For the ZHUN Soummam, the SD issues that are defined as strategic priorities are: social equity, environmental quality and governance.

It would then be more than necessary to develop, through the opportunities that the neighborhood offers, a potential scenario for an urban regeneration project. The main aim of this scenario, by seizing the resources and opportunities of the neighborhood, is to work on the weaknesses to control them and on the strengths to assert them. The legal and regulatory framework (SNAT-2030,

Algiers PDAU 2009-2035) also plays a decisive role in the success of this approach. It defines the general orientations of an urban regeneration operation and the priority themes that have the capacity to improve the condition of the Bab Ezzouar large housing estates.

In light of this, we have developed the potential scenario that takes advantage of the neighborhood's opportunities (socio-economic, urban, landscape, human, legal-regulatory, managerial), and their ability to bring about a lasting transformation of the neighborhood. The scenario exploits the neighborhood's advantages to improve scores according to the benchmark of values assigned to indicators. Results of the potential regeneration scenario show that most of the 20 themes of INDI-2012 can achieve a satisfying level of sustainability (Table 5).

According to the results, sustainability scores have moved from low to medium, to relatively high values. This corresponds to a change in the values of the sustainability barometer of INDI-2012. It shows a significant increase in the sustainability score of the evaluation themes. The results are represented by a graphical comparison between the sustainability scores of the two situations "before and after urban regeneration" (Figure 8).

Table 5. Results of the potential scenario of the neighborhood's regeneration project through INDI-2012 themes (Authors, 2024).

N°	INDI Themes	Potential Scenario (Urban regeneration)
1	Energy management in project design	**2,1**
2	Energy management in buildings	**2,3**
3	Light atmosphere	**3,7**
4	Travel management	**2,5**
5	Space consumption	**2,5**
6	Biodiversity	**2,7**
7	Sustainable water management	**2,8**
8	Sustainable management of materials and natural resources	**2,4**
9	Combating poverty and exclusion (employment and housing)	**2,7**
10	Accessibility to quality services and facilities	**3,8**
11	Quality of buildings, housing and private spaces	**2,9**
12	Quality of public and green spaces	**2,6**
13	Safety, risks, health and nuisance reduction	**3,1**
14	Participation in the collective effort and integration into the city	**3,9**
15	Solidarity and diversity policy	**3,0**
16	Culture, education and training	**3,4**
17	New way of thinking and acting (approaches, methods and tools)	**3,2**
18	Evaluation and capitalization as a method of learning and improvement	**3,0**
19	Partnerships	**3,3**
20	Involvement of residents and users	**4,8**

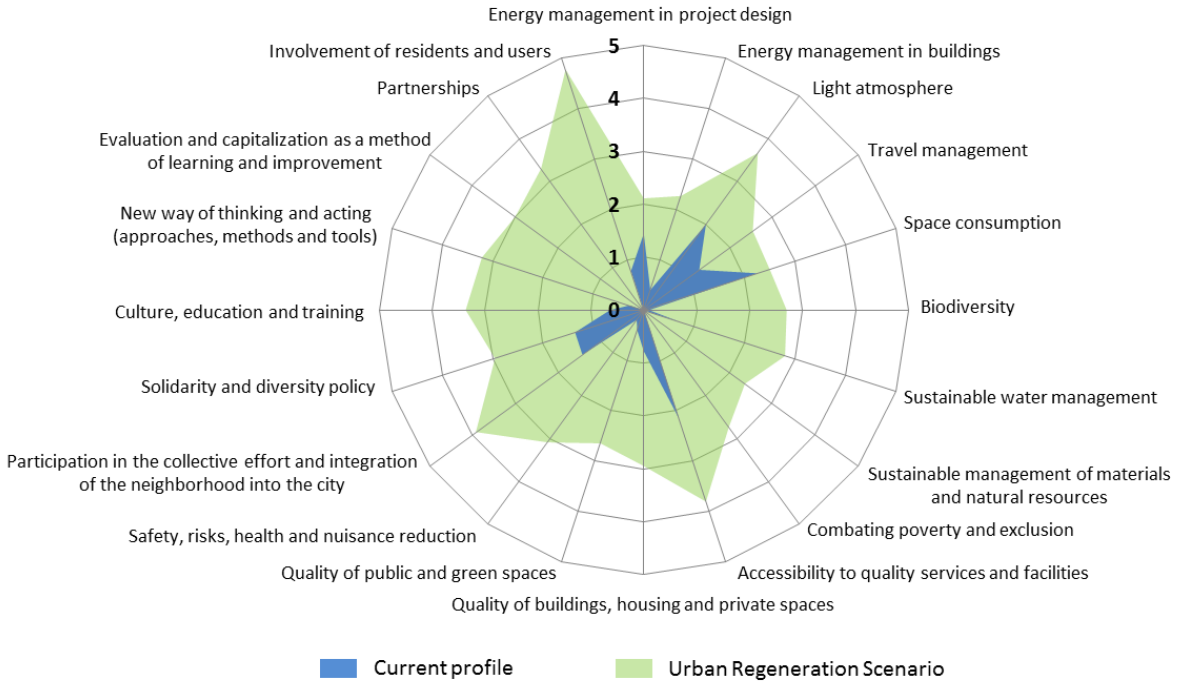

Figure 8. Radar chart representing the sustainability assessment profile of the ZHUN Soummam according to the 20 themes of INDI-2012 "Current profile versus Urban Regeneration Scenario" (Authors, 2024).

From the table below, the themes of the potential scenario are to be classified under three categories according to the barometer of sustainability:

- Moderately sustainable (Themes 1, 2, 4, 5, 6, 7, 8, 9, 11, 12, 15 and 18): They depend on a long-term policy. Nevertheless, the neighborhood shows a slight improvement on the themes of energy management, mobility, space consumption, biodiversity, sustainable management of water, materials and resources, employment, quality of buildings and outdoor spaces, social mix and feedback as a method of improvement. This is due to improved ratings for quantitative and qualitative indicators (with regard to Benchmark values).
- Almost sustainable (Themes 3, 10, 13, 14, 16, 17 and 19): These themes still need to be developed, given their important and imminent effect. For example, the "Safety, risks, health and nuisance reduction" theme can be better treated, according to international standards, to serve the urban resilience issue.
- Sustainable (Theme 20): This theme is the keystone of any ambitious urban regeneration project. Recourse to the efforts of the inhabitants is essential, given the nature of the neighborhood, which encourages exchange, mutual aid and citizen participation.

The results of the urban regeneration scenario demonstrate that the themes which marked mainly a remarkable improvement revolve around the human factor. From managers to residents, it is clear that the contribution of the efforts of urban actors to the quality of the urban environment is considerable.

The Urban Regeneration Scenario profile shows an intrinsic quality of the ZHUN Soummam to respond positively to the urban regeneration project.

In this way, the INDI tool demonstrates the capacity of the project to carry out, through an assessment of the potential scenario, possible changes in response to its four SD issues at the neighborhood scale (Table 6).

Combining the themes of INDI according to their purpose allows us to assign a score to each of the four SD issues, and allows us to make a comparison with the level of sustainability achieved, between the neighborhood's initial situation and the scenario of its future via the urban regeneration project (Figure 9).

Table 6. Distribution of themes on the four INDI-2012 issues for a sustainable neighborhood (Authors, 2024).

04 "INDI-2012" Issues	**Affiliated themes (No. mentioned in tables 4 and 5)**
Taking locally the large global issues	1 to 9
Responding consistently to local issues	10 to 13
Contributing to the sustainability of the city	14 to 16
New governance	17 to 20

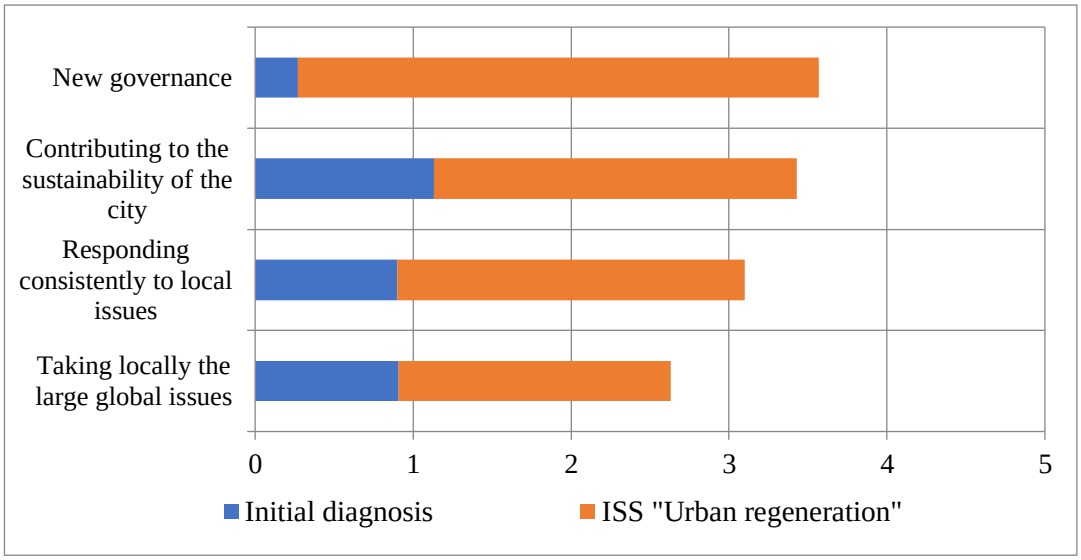

Figure 9. Improved Sustainability Scores "ISS" for the ZHUN Soummam apropos the four major issues of INDI-2012 (Authors, 2024).

As shown in the figure-9, scores on the four issues of INDI for a sustainable neighborhood testify an average improvement of more than 47%, compared to the initial situation. The histogram confirms that an implementation of an urban regeneration project is highly recommended to enhance the neighborhood's sustainability, and prepare its reintegration into the new strategic urban dynamics of metropolitan Algiers.

It would be therefore important to mention that the HQE²R approach offers the possibility of assessing the proposed scenario and comparing the results obtained with the shared objectives, previously drawn up by the urban actors. Therefore, it is possible through INDI-2012 to carry out by feedback the revision of the priorities assigned to the themes, as well as the readjustment of the model to meet the demands of the inhabitants. In the event of a divergence in the objectives or the prioritization of SD themes within the group of urban actors, it is also possible to develop a comparative study of the proposed scenarios in order to fine-tune the intervention strategy within the framework of an urban regeneration project.

Towards a new integrated decision support tool (Action plan).

The complex and multidisciplinary nature of the SD dimensions at the local level encourages researchers to further experiment and develop new operational tools. In order to achieve the objectives of SD through the policy of urban regeneration, all aspects affecting the quality of life and the urban environment must be taken into account. INDI-2012 as a new tool, thanks to its great adaptability to the context to which it applies, would be able to make crossovers between its issues and themes, on the one hand, and the guidelines and technical prescriptions laid down by the instruments of urban management, on the other. It can be used both as a tool for analysis and evaluation and as a tool for decision support on the nature of intervention. This new integrated decision-support

tool aims to define, according to a pre-established analysis, the type of project to be adopted and the methodology to be followed in a SD approach.

INDI-2012 also tries to clarify in a precise way the objectives to be achieved through an action plan (which defines the courses of action on which an urban regeneration project should intervene in order of priority and intensity).

Recommendations and actions to be taken.

The final phase of the HQE²R process outlines an action plan addressing four main issues for urban regeneration of Large Housing Estates of Soummam:

- *Global Issues at local level*
  - Energy: Reduce energy bills via audits, eliminate thermal bridges, and increase thermal inertia. Promote renewable energy and energy sobriety.
  - Public Lighting: Optimize night lighting to save energy and reduce light pollution.
  - Urban Transportation: Modernize public transport, promote cycling, and install electric charging stations.
  - Space Consumption: Redevelop no man's land for public spaces.
  - Biodiversity: Enhance natural ecosystems with endemic plants and wildlife-friendly features.
  - Water Management: Improve water quality and prevent intermittent supply through new techniques (rainwater harvesting and sewage treatment).
  - Combating Poverty: Prioritize employment, eradicate unsafe housing, and support the local economy.
- *Responding consistently to local issues*
  - Building Quality: Rehabilitate and upgrade buildings, ensuring functional diversity.
  - Public and green spaces: Integrate and maintain interstitial spaces with public amenities.
  - Risk Management: Improve air quality, reduce noise, prevent natural hazards, provide ORSEC plans (civil safety response organization), and manage waste effectively (selective sorting and intelligent underground containers).
- *Contributing to the sustainability of the city*
  - Neighborhood Integration: Reduce carbon footprint and support local economy growth.
  - Cultural Exchange: Promote social and intergenerational mix through cultural spaces (promote living together).
- *New governance*
  - Future Planning: Use scenario methods for future planning and establish an SD charter.
  - Partnerships: Foster collaborations among stakeholders.
  - Citizen Participation: Encourage involvement in all project phases for successful implementation (information, awareness-raising, consultation, collaboration, cooperation).

CONCLUSION.

The article discusses the urban regeneration project in Algiers, focusing on the implementation of the HQE²R approach in large housing estates, particularly in Bab Ezzouar. Algiers has adopted an urban policy through the "Algiers PDAU 2009-2035" to upgrade urbanized land and address socio-urban degradation. The city aims to positively impact neighboring towns, but local authorities lack operational tools for effective interventions.

The HQE²R approach is presented as a valuable methodology for regenerating large housing estates, offering both an exhaustive methodological basis and an operational decision-support tool. This approach involves all urban actors within a predefined socio-spatial framework. The study emphasizes the cross-sectional nature of the HQE²R tools, which analyze the neighborhood's socio-environmental setting.

The HQDIL method, a participatory approach, helps define the current situation and identify shortcomings. The INDI-2012 repository, based on a multi-criteria approach, establishes two neighborhood sustainability profiles: one for the initial diagnosis and another for the potential regeneration scenario. The results of the initial diagnostic profile confirm the critical state of the neighborhood's urban environment. The profile resulting from the potential scenario demonstrates the possibility of initiating a catch-up and upgrading process. While the urgency of regenerating Algiers' large housing estates presents challenges, the article suggests prioritizing interventions based on stakeholder requirements. Principles such as residentialization, differentiated management of public and green spaces, and citizen participation are crucial for successful urban regeneration. The study highlights that successful neighborhood regeneration depends on political will, operational instruments, and the involvement of residents and users. It emphasizes placing residents at the center of any urban environment transformation.

The article concludes by suggesting future research directions:

- Developing a proactive scenario for a long-term regulatory framework.
- Implementing an iterative process (proposal, application, evaluation, and audit) for the proposed action plan to ensure result reliability.
- Integrating actions and objectives into regeneration project specifications to provide methodological support for sustainable neighborhood development.

Overall, the study presents the HQE²R approach as an effective tool for urban regeneration in Algiers, emphasizing the importance of stakeholder involvement, sustainability, and long-term planning in creating successful urban environments.

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DECLARATION OF INTEREST STATEMENT.

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix 1. Excerpt from the sustainability barometer table according to the benchmark values of INDI-2012 (Charlot-Valdieu and Outrequin, 2012)

Indicator No.	Barometer of Sustainability (Index)					
	0	1	2	3	4	5
	Benchmark values					
1.1	0 - 20 %	21 - 40 %	41 - 60 %	61 - 80 %	81 - 90 %	91 - 100 %
1.2	Not considered		Partially taken into account		Well taken into account	Very well taken into account
1.3	Not considered		Partially taken into account		Preventive measures	Totally integrated
1.4 A	< 6 %	6 - 15 %	16 - 30 %	31 - 50 %	51 - 80 %	> 80%
1.4 B	< 15 %	15 - 30%	31 - 50 %	51 - 70 %	71 - 90 %	> 90 %
1.4 C	< 3 %	3 - 10 %	11 - 20 %	21 - 30 %	31 - 40 %	> 40 %
2.1 B	No statement of work (not taken into account)	Low thermal inertia of buildings		Mean Thermal Inertia		High thermal inertia of buildings
2.1 C	Average Not Known or >210 or E, F,G>40%	Average > 190 or E, F, G > 20 %	Average < 190 and E, F, G < 20 %	Average < 150 and E, F , G < 20 %	Average < 130 and E, F, G < 5 %	Average < 110 and E, F, G < 5 %
2.1 D	No account to be taken in zone H3	No allowance for H1 and H2 zones		Partially taken into account		Very well taken into account
2.4	< 0,5 %	0,51 - 1 %	1,01 - 1,5 %	1,51 - 2 %	2 - 3 %	> 3 %
2.5 A	≤ 0 %	1 - 5 %	6 - 15 %	16 - 30 %	31 - 50 %	> 50 %
2.5 B	≤ 0 %	1 - 5 %	6 - 15 %	16 - 30 %	31 - 50 %	> 50 %
3.1	> 30 lux	25 - 30 lux	20 - 24 lux	15 - 19 lux	11 - 14 lux	≤ 10 lux
3.2	Lack of action	Very inadequate measures	Rather inadequate measures	Average measures	Somewhat satisfying measures	Very satisfying measures
4.1 A	< 40 m²		40 - 50 m²	51 - 60 m²	61 - 75 m²	> 75 m²
4.1 B	15 - 25 m²	26 - 35 m²	36 - 50 m²	51 - 65 m²	66 - 80 m²	≥ 81 m²

Appendix 2. Excerpt from the neighborhood sustainability assessment table according to INDI-2012 repository (Authors, 2024)

N°	Indicators	Measuring the indicator (secondary indicators)	Benchmark Unit	Weighting coefficient	Initial diagnosis	Order of variation	Score Initial diagnosis	Score Potential scenario
ISSUE 1: LOCAL CONSIDERATION OF MAJOR GLOBAL ISSUES								
Sub-issues 1.1: Combating climate change and the greenhouse effect, preserving energy resources								
Theme 1: Energy management in project design								
1.1	Orientation of buildings and optimization of free solar input	General orientation of neighborhood buildings (mass plan analysis): share of well-oriented dwellings (according to the local situation)	91-100%	-	69%	Increasing	**3**	**3**
1.2	Microclimatic effects (heat sink, aerodynamic conditions)	Consideration of microclimatic constraints in the neighbourhood (wind, air currents, shadows…)	Very well taken care of	-	Partially taken into account	Increasing	**2**	**2**
1.3	Consideration of climate change	Measures taken on the water cycle (storm prevention, flooding, etc.), soil analysis, the nature of plantations and the orientation of buildings to prevent climate change (measures that need to be explained or justified)	Totally integrated	-	Not considered	Increasing	**0**	**2**
1.4 A	Energy self-sufficiency in the neighborhood (and use of renewable energy)	Rates of coverage of electricity needs (excluding Joule effect) by decentralized (solar, wind, micro-cogeneration, etc.) or centralized renewable energies	> 80%	1	< 6%	Increasing	**0**	**1**
1.4 B		Rates of coverage of heat needs by decentralized (solar, CAP, etc.) or centralized renewable energies	> 90%	3	< 15%	Increasing	**0**	**1**
1.4 C		Neighborhood energy self-sufficiency rate	> 40%	2	< 3%	Increasing	**0**	**1**
Theme 3: Light atmosphere (Lighting ambiance)								
3.1	Level of illumination of street lighting	Average illumination level for secondary and service roads in the neighborhood	≤ 10 lux	-	17.75 lux	decreasing	**3**	**4**
3.2	Light pollution	Measures taken to reduce light pollution at night	Very satisfying	-	Lack of action	Increasing	**0**	**3**
Theme 4: Travel management								
4.1 A	Parking for residential and tertiary buildings	Number of m² of Net Floor Area per parking space (residential buildings)	> 75 m²	2	97,82m²	Increasing	**5**	**5**
4.1 B		Number of m² of Net Floor Area per parking space (tertiary office type buildings)	≥ 81m²	1	83,33m²	Increasing	**5**	**5**
4.2	Access to structuring public transport	Number of housing units within 300 m of a structuring transit stop / Total number of housing units	96-100%	-	84%	Increasing	**3**	**3**

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