A review of the urban indicators experience and a proposal to overcome current situation. The application to the municipalities of the Barcelona province

Abstract

The review of the state of the art about the local environmental proposals which have come up after the 21 local agenda shows common patterns. They may be summarized in three main issues:

1. Proposals are very disperse in terms of content and scope and so linked to each specific city that make unfeasible an overall balance nor comparative analyses between cities.
2. Most of them are framed as a list of indicators but there are no priorities, causal scheme nor responsibilities allocation set up.
3. Some traditional indicators (waste generation, water consumption,...) have been transferred from one proposal to another without checking for the minimum quality criteria and therefore making them misleading and useless as local management tools.

Somehow, many of these limitations may be understood by the way as they were born, the timing, the underlying information and the social and political stress to prompt results. However, they also reflect the misunderstanding of the local role in the whole strategy for the sustainability. Urban proposals seem to be conceived as scale reproductions of the national ones with no reference to the administrative hierarchy nor land management rules.

The paper holds that much of the “so-called” indicators cannot be considered more than just local information without capacity to assess the local environmental achievements nor to provide guide for local intervention and establishes the criteria to rethink them. With these criteria in mind, a set of core indicators involving water cycle, solid wastes, land use and air for the municipalities of the province of Barcelona (over 300) have been defined and results are shown and discussed.

Area

Session 2D- 3 SUSTAINABLE CITIES
1. Objectives and Scope

The research underlying this paper attempted to define a set of indicators able to furnish local municipalities with tools to monitor and evaluate their environmental performance. Although right after the Agenda 21 many municipalities have tried to set their own strategies and have come up with different proposals, the research attempts to surpass individual actions and set a common core of indicators for wider application.

At this stage, there is no doubt that each program and each municipality will require their own and specific indicators in accordance with their objectives. Bearing this in mind, the aim of the research was the definition of a set of core indicators for general application across different municipalities and capable to be added to the already existing socioeconomic and territorial indicators (employment rates, housing development, activities growth,...) at the local level. Thus, monitoring on local environmental progresses could be upgraded to the rest of the issues. Of course, it does not preclude each municipality to add their own indicators according to their physical specificity or environmental strategy.

As a first step, the research included a review of the state of the art on the local environmental proposals to guide the criteria to set up the indicators. Next steps towards the indicators selection and its application grounded on the existing information system on local environment promoted by the Diputación de Barcelona in 1990 and intended to cover the 306 municipalities included in the province. Although the research took a methodological perspective, the contrast...
with the existing data helped to recognize the statistical constraints, to confront current situation with the desirable patterns and to apply the proposed methodology.

In turn, one expects that the result may also provide to the environmental information system with some insights for its future development.

2. The review of local environmental indicators

As a first step, the review of previous development on local indicators abroad highlighted three main features on the state of the art in the field research:

1. Widespread approaches as the result of locally fitted proposals which make unfeasible at this stage any attempt to pursue an overall analyses on the existing data.
2. Lack of any indicators framework. Thus, many appear as a list of isolated indicators with no reference to the underlying causality model, hierarchy and coherence.
3. Inconsistency among the so-called sustainability indicators and their real content as well as the local capacity to intervene.

The review of different proposals already in place in mainly European cities came up with over 200 indicators involving the same fields and showing some common patterns although generally formulated alike. Thus, within the water supply indicators on consumption rates and water quality are generally included although the way they are formulated varies widely along the proposals.

This is not the case on wastewater treatment where common patterns could not be well identified. Somehow the proposals included two types of indicators. A first group concerned the environmental state and wastewater quality while a second group referred to the treatment systems. Nevertheless big divergence between presentation made unfeasible to select common indicators.

On solid wastes, there is a wide set of indicators on generation (by kind, sectors, population…) and another on the recovery and treatment.

Under the air vector the proposals include emission, response and quality indicators, being this last one the most widely represented all across the cities under consideration. Again, the parameters differ among proposals but it is still the vector which generally best embraced the whole impact-effect path.

Besides, the proposals used to include a broad range of issues related to the physical environment, energy, transportation and many other social aspects.

Under the physical environment there is a diversity of indicators concerned with urban pressure (growth, roads…); land uses and biota quality (forest and agriculture, biodiversity, derelict land, contaminated soils,…), public response (protected areas, green spaces, pedestrian paths,…) and aquatic environment
(watershed pollution, river banks). However, among the diversity there are two themes which seem more frequently addressed, soil pollution, derelict lands and green areas.

Many proposals include indicators on energy consumption and transportation demand by modes, also with varied formats. Finally, recent proposals provide also indicators attempting to capture other ways of human welfare. Among them there are income rates and distribution patterns, indicators on poverty, activity and unemployment, social participation, criminality, housing and public services or life quality perception.

Partly, the stated diversity is the outcome of the isolate initiatives. Joint developments involving many municipalities are scarce. To my knowledge, the ABC model of the International Institute for the Urban Environment is one of the first attempts to define a core of common indicators commonly applied everywhere and more recently, Ambiente at Italy worked with a set of 100 cities all together. Certainly, searching common indicators for different municipalities is more demanding and the criteria for selection is necessarily more stringent, as discussed below.

The second conclusion out of the review is that although indicators have proliferated after the mandate of the agenda 21, the fact is that proposals tend to lack of a real framework showing the underlying strategy. There are not too many classifications which could be operational as indicators of the achievements and the effectiveness of the local undertaken actions. The set of objectives at all level, from the operational to the strategic ones, is a “must” before the selection of indicators if they attempt to guide local actions. From our viewpoint, many indicators are still mere descriptors, with no targets attached to them and they are listed with no hierarchy nor causal relationship.

Eventually, the third conclusion relates to the indicators scope. There is among the proposed indicators a mixture of environmental and quality of life indicators (green areas, open access are together with natural endowments maintenance) with no guarantee of internal coherence. On the other side, the guidelines drawn by the international programs (Agenda 21, Vth Programme,...) and which lead many local agendas do not able to precisely set the clear-cut and the standards to ensure sustainability. No doubt these issues would be a top priority next years but the situation nowadays is such that the proposals cannot accurately be named as sustainable indicators. More properly they can be just understood as indicators for environmental monitoring. Moreover, social participation systems, extensively used lately, contribute to the social awareness and responsibility in the setting of environmental targets but results of previous research on perception in the Lancashire project (Taylor,D.,1996), for instance, or the works of Bonnes,M. and Bonaiuto,M.(1991) open some queries on the social participation role to define core indicators.
Besides, some of them are misleading for evaluation and comparison purposes or their main drive remains beyond local responsibility. This is the case, for instance, for waste generation where differences among municipalities range widely according to the seasonal population and the commuting patterns. Then, local differences cannot be easily attributed to differences in management quality nor even shifts along time within one municipality can be unambiguously understood. Even as a target its value is doubtful as local capacity to modify consumption habits is really limited. Also, transportation patterns or energy consumption among many others lie on the metropolitan structure with no feasible changes in the short term and to a large extent out of the municipality intervention. Development stages could also explain differences among municipalities to the fact that environmental efficiency cannot be analyzed without other welfare measures as the service provision. As it can be shown, these criticisms apply to most of the so-called pressure indicators, and therefore they deserve a lot of attention before being recommended as part of the core indicators.

Without all these considerations in mind, indicators cannot play much more role than being at most descriptors of the current situation but they would remain far from being indicators of the local action effectiveness and of their contribution towards the sustainability. Probably, most of these shortcomings arises from the genesis of the local indicators. It looks like the macro schemes (OECD, EUROSTAT,...) were transferred at the local level to territorially allocate the pollution problems but without full acknowledge of each actor’s role within the sustainability strategy. Nevertheless, the government level at which these proposals apply does matter and indicators at the national level cannot be transferred to the regional or local ones without consideration of each administration responsibilities.

3. Criteria to set up indicators

Following the conclusions from the previous analysis the issues to consider at the time of setting up local environmental indicators are classified into three main areas: underlying strategy, operational use and aggregation systems.

**Environmental strategy and indicators**

Very often, the search of indicators has anticipated the thought on the strategy and the environmental targets. That fact would explain why the local proposals show indicators which are seemingly unrelated and, anyway, lacked of hierarchy.

The validity of the indicators system relies on the envisaged objectives. Without well framed objectives and quantified targets there are no references nor priorities to intervene, nor later on to judge the effectiveness of the actions.

The whole process of the local environmental agendas and the indicators proposals keeps many common features with the evaluation process in public
policies and the methodological developments in the EU provide some useful insights for this field.
In this policy cycle the indicators are just the last step in the full scheme. They are the tool to manage evaluation, while the evaluation itself is a part of the policy development. The objectives to pursue provide the key elements to monitor and assess and, in turn, the results of this evaluation furnish the program with new clues to redefine objectives.

The review of local environmental indicators leads to the conclusion that this cycle have not been well followed. The lack of a fully developed strategy with its corresponding objectives and targets would explain the lack of frame in the indicators proposals later on.

Despite the recent display of local initiatives, the truth is that the experience in the environmental indicators development is still limited. Efforts have tended to be isolated and with scarce resources. This situation differs from the one in the European funds evaluation, and would reveal why development on this side seems to have been less.

Urban environmental indicators differ in their scope and have been in the past lacked of systematization although the PSR model is gaining adepts among the new proposals. The three category classification, Pressure, State and Response relies on the fact that pressure on the environment, soon or later, implies changes in its quality, in its state. Would these changes be perceived as non-desirable they lead to policy responses tended to control the pressure.
Thus, the PSR model embodies the principles of the policy generation, linking the indicators to the objectives hierarchy. Of course, the use of the PSR model does not ensure nor the coherence of the issues involved nor the completeness of the system and cannot replace itself the lack of strategy. Nevertheless, as far as it categorizes the indicators, it has an educational role whenever this strategy has not been defined at the onset.

From the operational viewpoint, the model is ready to support quantitative targets and help the monitoring and evaluation process. Chart 2 shows the link of each type of indicators with the policy intervention.

Chart 2. *Hierarchy of objectives in the program intervention and indicators system for monitoring and evaluation*

**Information system versus indicators**

The challenge for an indicator system to become operative is not as much the lack of information as it is its usefulness to the decision making process (Brink, B.T., 1991).

The statistics have to be organized, ranked and referred to a target to become indicators. Some data out of the available information will be dismissed in the process of selection of indicators. Their legitimacy arise from the context where they are built and from their ability to capture the essence of the objective they serve to. (Boer et al., 1991). In this sense, the system of indicators must be the outcome of a commitment between its scientific value, its statistical availability and its conciseness to help:
1. To Plan intervention, identify the problem, allocate resources and monitor and evaluate; and
2. To communicate, highlight and legitimate intervention

With this in mind, there is no way to point out a universal set of indicators, able to be used everywhere and in the same manner and without consideration of social beliefs, values and ethical standards. (European Commission, 1996; Boer, J. et al., 1991, Dror, 1986). The selection is a hard task and will always involve some arbitrary decisions although, if understood as a dialectic process, the search of indicators would entail further understanding on the phenomena and the relationships (Levett, R., 1996). The dialectic process needs a reference frame, like the PSR model, and the indicators have to fulfill a minimum quality criteria. These criteria may be summarized as follows:

- Scientific validity
- Data support to allow for monitoring over time
- Sensibility to environmental changes
- Representativeness
- Relevance to the objectives
- Reference to the target set

These apply everywhere and need to be checked out when selecting the core indicators.

**The aggregation system**

The availability of many independent indicators allows to assess the individual effectiveness of each action but cannot reach the understanding of the overall intervention. In theory, the integration should be achieved by weighting each indicator according to its contribution to the next objective. However, the diversity of indicators involved and the state of knowledge in terms of causality relationships does not ensure this procedure can be widely applied.

When transformations cannot be approached by the use of physical properties, like in the NAMEA system of Netherlands, others proposals like WTP, experts’ systems or standards have been proposed in the literature although developments in this field are still to come. In fact, significant benchmarks like the recent works of the United Nations proposals are still avoiding the issue. (UNCHS, 1996).

Questions around the aggregation of indicators are mainly twofold. The first issue refers to which weight should be assigned to each indicator and second to which properties are desirable for the combination. By properties one means for instance to decide whether negative values in one indicator can be offset by positive one in any other. One virtual solution to deal with compensation effects was proposed by Ott (Ott, 1978) with a nonlinear function of this kind:
\[ I = \left( I_1^p + I_2^p + \ldots + I_n^p \right)^{1/p} \]

on \( I = \) Index value
\( I_i = \) Subindex
\( p = \) exponent

For \( p = 1 \), the index value is a linear function of its components while the greater value for \( p \) the closer the result to the highest value of the components.

Additionally, different unity of measure for each indicator still requires a previous transformation of these primary indicators. Some authors proposed to rank the individual values for each observation (municipality) regarding the best positioned one (Ott, 1978; Biehl, 1986; Siegel, 1995). Then, all indicators are transformed into distance indicators towards the best reference. That allows also to solve another problem like it is the lack of targets to reach. Then, all municipalities are ranked with regard the best one. When the target is determined by the strategy, then it becomes the reference instead.

Other attempts to get aggregate values involve the estimate of latent values (on quality, satisfaction,…) by applying multivariate analysis (Adelman and Morris, 1967; McGranahan et al., 1972; Harbison, 1970). All these procedures rely on the availability of a higher number of observations highly interrelated. The procedure has been extensively applied in other fields but the environmental indicators can hardly show the properties it would need.

Our conclusion at this stage of the analysis is that despite the interest of searching aggregate indicators, there is not yet evidence of the sound procedure to follow. When abundance of indicators closely linked exists, the multivariate analysis seems very attractive. Otherwise, the aggregation criteria will still entail arbitrary decisions and will be controversial. The experts option raises doubts on the weighting reliability. Local intervention cannot be evaluated without considering local strategies, so expert weighting may not be transferable from one area to another and advantages of this system over other simpler and objective are not evident.

4. The RIRA experience

The baseline for the research application is furnished by the information system, RIRA. The RIRA is an ambitious and at its start innovative project promoted by the Diputación de Barcelona (province government). It was conceived in 1990 when much of the literature on local sustainability indicators did not exist as an information register of local environmental resources. It intended to help local authorities to become aware of their situation by providing information on it and to be an aid for them to develop their own strategies. Therefore, the system did not pursue most of the objectives associated to the indicators themselves. Instead, it did provide the data to make feasible later on the existence of indicators.
As a merit, in front other sources of data, it was born at the local level, being the municipality the unit of reference, and the whole construction intended to serve local policies.

The register had a multi-sectoral and multi-functional character as far as it dealt with many vectors (water cycle, solid wastes, air, non urban land and coastal zones) and different aspects of each one (characteristics of the resource, uses, equipment, economic issues and organization). Beginning in 1990, the project has had various phases including each time different municipalities of the province and improving its content until the full coverage in 1993. The whole province includes 306 municipalities. Therefore the units involved in the system cover a wide range of areas in many senses: population, surface, activities, climate and so on.

Former research had just focused in partial aspects of the environmental management and never embraced all the vectors. Therefore, with no actual precedents, the definition of the data system was a challenge itself and opened at that time a new front without the international references already developed by now.

With this information system in the grounds, the research aims to go a step forward in the elaboration of an indicator system applicable to the whole province. The existence of the Information system allowed to set the research on real grounds and to make it well aware of the existing constraints. In turn, the research intended to be helpful to reassess in the future the efficacy of the register. Despite the chronological succession, the information system should be aware of the outcome of the indicators research as far as it has to provide the inputs for the indicators systems to be successful. The outcome of the research is mainly methodological. The figures obtained for the indicators through the exercise have mainly an illustrative value since the data for each municipality dates to few years ago and the situation may have hopefully evolved since then.

5. A proposal for a set of core indicators

The core indicators system aims to furnish local authorities with the tools to monitor their environmental performance in a similar way as they already can do with other social and economic indicators (unemployment, demographic dynamics, income rates...). It does not preclude individual municipalities to set their own indicators to monitor and evaluate their programs.

The selection out of the existing information system and attempting to fulfill the quality criteria already stated leaded the research to the establishment of some premises which are summarized below.

1 Underway, there is an updated review that will be promptly released by the Diputación de Barcelona.
1. The set was restricted to those indicators which performance lies on local responsibility. Therefore, the proposal focused on those indicators which are useful for monitoring and evaluation of local performance and avoided those general ones that although territorially applied cannot be substantially intervened by local authorities.

2. The system applied to the water cycle, solid wastes, land and air because of the information system scope. Mobility, transport or energy could not be embraced under this research. Coastal management was left out because it does not imply all the municipalities.

3. The proposal recognized the quality attributes of the PSR model although it got restricted to the Response indicators.

4. Indicators on the environmental state are not available in the information system. Otherwise, they could have been incorporated similarly as the Response ones.

5. On the Pressure indicators we held a quite different view. Traditional pressure indicators as generally applied everywhere were available in the information system. However, they were dismissed because they do not fulfill the criteria for being good indicators. This probably is one of the main contributions of the research, since it is believed that the chances to define good pressure indicators in the core system are fairly limited and deserves further research. Again, this conclusion does not preclude that they may be defined by each municipality although the traditional ones (waste generation, water consumption and so on) as they are nowadays cannot be generally valued as good indicators for monitoring and evaluating the local performance. They will keep providing information as descriptors but they are not indicators, properly speaking.

6. The Core-Response indicators were divided into two groups, Structural (S) and Functional (F) core-indicators. The distinction seems very useful from the managerial viewpoint as the mobile, actors and time span differ among the two groups. In fact, if they are well defined and quantified the functional indicators can approach better the smooth and continuous changes in the environmental management while the structural indicators will be conditioned by investment decisions and will show a more discontinuous path.

7. The review of the international programs did not allow to set the targets or benchmarks for each vector nor the province government had not been established any target to refer to, either. With these constraints, the procedure to follow was the standardization of the indicators regarding the best positioned municipality in each one, that takes value equal 100. Thus, the system allows to rank municipality regarding the best practices so the closer the value to 100, the best municipal practice.
8. All municipalities are considered equally disregarding its positioning and size. That option breaks the way how social and economic issues have been traditionally approached. The decision is justified by the following reasons:

- The system attempts to assess the goodness of local environmental practices and therefore each administrative body is evaluated under the same criteria.
- The core indicators are a set of minimum, a must everywhere. Moreover, there is no correspondence between population size and wealth in one side and environmental responsibilities in the other. In fact, small municipalities in size and wealth may be managing very large land surface and very valuable ecosystems. Only ecological capacity could have been selected as the criteria for discrimination but the complexity of the approach let us leave it out for now.
- Finally, there is a consistent motif to proceed that way: territorial interdependence do not recommend to limit effects of the local actions to the own spaces.

9. Eventually, 22 indicators were selected among the information system (see chart 3 below)

<table>
<thead>
<tr>
<th>Environmental Vector</th>
<th>Indicator</th>
<th>Description</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water supply</td>
<td>ABASTA_VIV</td>
<td>Households with public supply (%)</td>
<td>S</td>
</tr>
<tr>
<td></td>
<td>CNSUM_C_A</td>
<td>Metered consumption over total (%)</td>
<td>S</td>
</tr>
<tr>
<td></td>
<td>APROFITA</td>
<td>Water distributed over total provided to the network (%)</td>
<td>S</td>
</tr>
<tr>
<td></td>
<td>FUITESC</td>
<td>Campaigns for monitoring water losses(Yes/Non)</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td>TARIFAC</td>
<td>Block tariffs (Yes/Non)</td>
<td>F</td>
</tr>
<tr>
<td>Sewage</td>
<td>SANEJA_VIV</td>
<td>Households connected to the sewer (%)</td>
<td>S</td>
</tr>
<tr>
<td></td>
<td>SANEJA_IND</td>
<td>Enterprises connected to the sewer (%)</td>
<td>S</td>
</tr>
<tr>
<td></td>
<td>DEPU_AMB</td>
<td>Householders connected to the sewer and with wastewater treatment(%)</td>
<td>S</td>
</tr>
<tr>
<td>solid Wastes</td>
<td>SERV_POB</td>
<td>Population with waste collection service (%)</td>
<td>S</td>
</tr>
<tr>
<td></td>
<td>REC_VIDRE</td>
<td>Glass collected selectively (Yes/Non)</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td>REC_PAPER</td>
<td>Paper collected selectively (Yes/Non)</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td>REC_PILES</td>
<td>Batteries collected selectively (Yes/Non)</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td>REC_RUNES</td>
<td>Rubble collected selectively (Yes/Non)</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td>REC_VOLUMI</td>
<td>High-volume wastes collected selectively (Yes/No)</td>
<td>F</td>
</tr>
<tr>
<td>Land</td>
<td>PROT_SPF</td>
<td>Protected surface over total surface (%)</td>
<td>S</td>
</tr>
<tr>
<td></td>
<td>SOL_NOURBA</td>
<td>Non_urban surface over total surface (%)</td>
<td>S</td>
</tr>
<tr>
<td></td>
<td>NETEJA_CAMINS</td>
<td>Forest paths cleaning</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td>RON_GUAR</td>
<td>Police and rural guards supervision</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td>PREV_INCENDIS</td>
<td>Fire prevention (Yes/No)</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td>NO_URBAN_IL</td>
<td>Fully legalized urbanization (Yes/No)</td>
<td>S</td>
</tr>
<tr>
<td>Air</td>
<td>EMISSIO</td>
<td>Vehicle emission control (Yes/Non)</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td>IMMISSIO</td>
<td>Air quality control (Yes/Non)</td>
<td>F</td>
</tr>
</tbody>
</table>

10. To reach synthetic indicators, first for each vector and for the whole system, later on, the research carried out some steps. The first problem to face was the missing of municipalities in the way towards the synthetic indicator. A synthetic index for functional indicators -IGAf-was available for 121 municipalities, the

\[2\] The number of industrial jobs was used as a proxy of number of industries which was not available.
synthetic index for structural indicators -IGAe- for 28 and only 21 municipalities could get a total synthetic index on environmental management -IGAt-.

11. The information required to the municipalities to complete the database was not provided either because it was unknown or not easily accessible or because the city council rejected the instrument. In the two cases, the missing is meaningful. In order to incorporate this meaningful information into the system, the research attempted to value the missing indicators following the next steps. Those municipalities with did not provide any indicator in one vector were left out of that vector. However, when there was some other indicators available in that vector, the missing one was replaced by the minimum value of the indicator in the rest of municipalities with data. In that way the lack of knowledge penalizes as inadequate management. With these replacements the indicators were available up to 261 municipalities (see Annex for the comparison of results under the two samples).

12. Second, it was necessary to define the aggregation system. As expected, the factorial analysis revealed a very low correlation among indicators. Although this fact is a good feature on the system design and performance, it cancels any attempt to use this statistic approach to obtain synthesis results. The option of experts’ participation to provide weights for each vector was dismissed because the procedure involved a lot of judgment when the diversity of the areas could not guarantee better performance. Finally, the option consisted in the estimate of arithmetic averages of the values of the indicators in each vector\(^3\) although a further research on the desirable properties of the aggregation system is envisaged for the future. As example of the indicators obtained, the annex show the mean values of the synthetic indicators by vectors and for the whole system.

6. **New insights for the future**

The selection proved that despite the range of data covered by the information system, many relevant questions remained still unanswered. In fact, the sample of municipalities covering all the data involved in the indicators went down and the indicators could not be fully estimated for all the province. From our view, it was the lack of well defined objectives for the information system at its start that dispersed efforts and leaded to lots of information with no relevant contribution to the analysis. The knowledge got since the beginning of this initiative in terms of local agendas and indicators criteria should help to rethink the information system and to tackle more accurately the priorities.

The research attempts to provide some guidance to progress towards a higher quality data. Fourteen out of the 22 indicators are just qualitative, with a dichotomous response, violating the sensitivity criterion. Sometimes, the shift into

\(^3\) Synthetic indicators, IGAf, IGAe and IGAt, were also estimated with the non-linear function proposed by Ott (1978) for \(P=2\) and \(p=3\). The results under these nonlinear functions showed high correlation with the adopted ones, \(0.9743\) for \(p=2\) and \(0.9336\) for \(p=3\).
quantitative indicators seems fairly straightforward, like it is the case for the selective waste collection. Some other times, it will require further search.

Indicators on mobility demands seem to us hard to evaluate under local premises. The full demand is driven by upper local patterns, and therefore would not be recommended within the core set. Only allocation between public and private transportation could be assessed as an indicator of good local practices.

Furthermore, indicators on green areas for public access, do not seem easily incorporated into the core set, either. Differences in urban structures would seriously condition its meaning. Therefore, we hold the higher significance of non-urban land over total surface to express the control on land humanization.

Bearing in mind the statistical constraints at the local level, the proposal for a first step improvement of the current set of core indicators would include:

<table>
<thead>
<tr>
<th>VECTOR</th>
<th>INDICATOR</th>
<th>Current characteristics</th>
<th>A FIRST-STEP-CHANGES PROPOSED</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABASTA</td>
<td>FUITESEC</td>
<td>Qualitative indicator Monitoring on water losses</td>
<td>Quantitative indicator Man hours per network length</td>
</tr>
<tr>
<td>SANEJA</td>
<td>DEPU_AMB</td>
<td>Qualitative indicator Treated Wastewater</td>
<td>Quantitative indicator Wastewater under secondary and tertiary treatment (%)</td>
</tr>
<tr>
<td></td>
<td>NETEJA.IMBORNAL S I MANTENIMENT XARXA</td>
<td>New indicator to keep track of the sewer system control Cleaning of scuppers and network maintenance</td>
<td>Man hours per network length</td>
</tr>
<tr>
<td>WASTES</td>
<td>SERV_POB</td>
<td>Underestimate of seasonal residents Population with waste collection service (%)</td>
<td>Households with waste collection (%)</td>
</tr>
<tr>
<td></td>
<td>REC_VIDRE</td>
<td>Qualitative indicator on selective collection service for glass, paper, batteries, rubble and high-volume debris</td>
<td>Effectiveness on the collection (tones collected over total wastes)</td>
</tr>
<tr>
<td></td>
<td>REC_PAPER</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>REC_PILES</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>REC_RUNA</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>REC_VOLUMI</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LAND</td>
<td>NETEJA_CAMINS RON_GUAR</td>
<td>Qualitative indicator Forest paths cleaning Police and rural guards supervision</td>
<td>Man hours per non urban surface (ha)</td>
</tr>
<tr>
<td></td>
<td>PREV_INCENDIS</td>
<td>Qualitative indicator Fire prevention</td>
<td>Man hours per surface (ha) (Need for further search on equipment and services)</td>
</tr>
<tr>
<td></td>
<td>URBAN_IL</td>
<td>Qualitative indicator Fully legalized urbanization</td>
<td>Non legal Households Surface occupied</td>
</tr>
<tr>
<td>AIR</td>
<td>IMMISSIO</td>
<td>Qualitative indicator Air quality control</td>
<td>Monitored surface (%)</td>
</tr>
<tr>
<td></td>
<td>EMISSIO</td>
<td>Qualitative and partial indicator on Vehicle emission control No mention on fixed sources</td>
<td>Controlled sources over total (%) Sources over quality standards over total sources under inspection</td>
</tr>
<tr>
<td></td>
<td>NOISE</td>
<td>New indicator Noise control</td>
<td>Controlled sources over total (%) Sources over quality standards over total sources under inspection</td>
</tr>
<tr>
<td>TRANSPORTATION</td>
<td>PUBLIC</td>
<td>New indicator Trips under public modes over total trips</td>
<td>Trips under public modes over total trips (%)</td>
</tr>
</tbody>
</table>

Further from the information system which helped to develop this application, the research pointed out that indicators might not stand on solid strategies and they do not respond to the monitoring and assessment role they should. Then, it
suggests the review of the indicators included in many of the local proposals bearing in mind local responsibilities in the way towards the sustainability.

Finally, it seems obvious from this results than many questions remain still open and that some of the taken options will deserve more attention and deeper analysis in future research.
Annex

**Average values for the aggregate and synthetic indicators** (missing values are not included) (Maximum value equal to 100)

<table>
<thead>
<tr>
<th>VECTOR</th>
<th>TYPE</th>
<th>AVERAGE</th>
<th>VARIANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>WATER SUPPLY</td>
<td>STRUCTURAL</td>
<td>88.2</td>
<td>139.7</td>
</tr>
<tr>
<td>SOLID WASTES</td>
<td>STRUCTURAL</td>
<td>84.9</td>
<td>977.2</td>
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<tr>
<td>WATER SUPPLY</td>
<td>GLOBAL</td>
<td>77.2</td>
<td>263.3</td>
</tr>
<tr>
<td>SEWAGE</td>
<td>GLOBAL</td>
<td>73.7</td>
<td>300.9</td>
</tr>
<tr>
<td>SEWAGE</td>
<td>STRUCTURAL</td>
<td>73.7</td>
<td>300.9</td>
</tr>
<tr>
<td>LAND</td>
<td>STRUCTURAL</td>
<td>53.1</td>
<td>293.3</td>
</tr>
<tr>
<td>WATER SUPPLY</td>
<td>FUNCTIONAL</td>
<td>52.0</td>
<td>1217.2</td>
</tr>
<tr>
<td>LAND</td>
<td>GLOBAL</td>
<td>49.8</td>
<td>290.4</td>
</tr>
<tr>
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<td>GLOBAL</td>
<td>47.6</td>
<td>292.8</td>
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<tr>
<td>SOLID WASTES</td>
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<td>39.6</td>
<td>423.1</td>
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<tr>
<td>LAND</td>
<td>FUNCTIONAL</td>
<td>39.4</td>
<td>605.0</td>
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<tr>
<td>AIR</td>
<td>GLOBAL</td>
<td>3.5</td>
<td>220.7</td>
</tr>
<tr>
<td>AIR</td>
<td>FUNCTIONAL</td>
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<td>220.7</td>
</tr>
<tr>
<td>IGAt</td>
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<td>50.1</td>
<td>77.3</td>
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<tr>
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<td>STRUCTURAL</td>
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</tr>
<tr>
<td>IGAt</td>
<td>FUNCTIONAL</td>
<td>31.97</td>
<td>175.04</td>
</tr>
</tbody>
</table>
Note on translation:
“AMB_TOT” means IGAt; “AMB_EST” means IG Ae and “AMB_FUNC” means IG Af.“Segons dades” is the result for the sample without missings; “Estimació missings” is the result for the missings with replacement.
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