

Local-area sustainability assessment system: a theoretical and operational overview

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Word count: 3,532

Key words: sustainability assessment, local governance, DPSIR, integrated assessment, indicators, multidisciplinary assessment

Abstract

This paper provides a theoretical and operational overview of a new integrated urban sustainability assessment framework named as Local area Envisioning and Sustainability Scoring system (LESS). LESS allows the monitoring, mapping and measurement of indicators from four fields of relevance to local government areas: environment, socio-economic, infrastructure and governance. The assessment of chosen indicators is conducted by taking into account the priorities and aspirations of a local government. The framework is used to create a unified-weighted index (on a scale of 0 to 10) to indicate the state of “health” of each field, in addition to a combined ranking taking into account all four fields. The framework is based on Drivers-Pressure-State-Impact-Response (DPSIR) concept. The basic premise behind this concept is that environmental changes are brought about by drivers, and caused by pressures. These changes impact communities as they interact with the demographic, social and economic factors that influence human well-being. In turn, communities respond with measures for mitigating and adapting to environmental changes. LESS is aimed to be a simple, flexible and customisable assessment framework.

1. Introduction

Cities in Australia, as in most other countries are the centres of socio-economic, cultural, and political activity. The environmental health of a city is a measure of its liveability and well being of its citizens. There is an increasing realisation that the battle for sustainable development is going to be won or lost in our cities; and that a sustainable world is not possible without sustainable cities (Girardet 2003, UNEP 2007 etc). This has serious implications for architects, urban designers, urban planners, and decision makers (built environment professionals) throughout the world: the onus of creating a sustainable world, indeed of the future existence of human race, has suddenly been passed on to them. It is a challenge that has to be accepted.

1.1 The challenge of urban sustainability

The challenge is particularly difficult because of the way our cities have evolved historically. In the 20th century function and rationality were the main considerations for planning cities. As a result the thrust of the economy became intense, and people believed that it was the norm to pursue an economy-led life (Jones, 1998). Consequently the cities were constructed to be increasingly practical and provided more and more economic growth opportunities. They became the destination for fulfilling peoples' aspirations for material comfort, safety, and prosperity. Over time cities became associated with the seats of government, the drivers of economic growth, the centres of culture and knowledge, and the rural areas with agriculture (Rees, 1999). However cities all over the world also started struggling with problems such as deprivation and alienation, crime and social discontent (see for example Girardet, 2003), in addition to being epicentres of consumption. Today cities have come to have a significant environmental impactⁱ at local and global levels and are generally considered unsustainable. Defying the course of history that cities have taken and making them sustainable is by no means a trivial task.

Another key reason that makes the challenge of pursuing sustainability onerous is the fact that there has been little agreement among the experts about the nature and definition of sustainability (see for example Holdren et al., 1995; Marker 2005). People's values about the kind of world they want to live in and leave for future generations are not common. As a result there are multiple perspectives on what sustainability means; how it should be achieved; what to sustain, how to sustain, and for whom (Marker 2005). As a result any concerted effort in the direction of sustainability becomes difficult, particularly in democratic societies like Australia.

1.2 Meeting the challenge

The challenge can be seen as being embedded in issues pertaining to 'sustainable urban management', and 'stakeholder consensus'. The built environment industry (architectural design, planning, construction and research organisations) has responded to the challenge by devising and adopting innovative tools and practices in their works. One such example in the pursuit of sustainable urban development involves the development of an integrated sustainability

assessment framework: Local-area Envisioning and Sustainability Scoring system (LESS). This framework is expected to meet the aforementioned issues in the following ways:

- As assessment and measurement is essential to any management effort, LESS' ability to assess and measure/quantify the state of sustainability of urban environment is a key step in sustainable urban management;
- LESS allows built environment professionals and stakeholders to identify and understand the issues relevant to sustainability, set goals and monitor progress thereby facilitating consensus for decision making.

This paper outlines the theoretical overview of the framework. The purpose is not only to report on the development of this framework so far, but also to seek feedback from the academia and potential users to guide its future development.

1.3 Outline of the paper

This paper gives an overview of the concept behind this framework. A brief review of the existing urban assessment system, State of Environment (SoE) reporting is given first to highlight its limitations. A brief review of some recent urban assessment systems is cited from literature to highlight the gap in knowledge that needs to be addressed. Next, the methodology behind the framework is explained which involves a description of LESS in terms of its structure and functioning followed by details of its building blocks, and their interrelationships. Outcomes of LESS are discussed to demonstrate how it can address the limitations of SoE and other assessment systems. The paper concludes with a brief statement on the strengths and limitations of LESS and future steps envisaged for its development.

2. Current state of urban sustainability assessment

Assessment of the urban sustainability is an essential step towards moving closer to sustainability. The key premise behind this being—'what cannot be measured cannot be managed'. Assessment of sustainability in Australia at city or larger level is predominantly conducted with State of Environment (SoE) reporting (Commonwealth of Australia 2009).

SoE reporting is a well accepted and widely used tool in Australia and other OECD countries for monitoring environmental sustainability. SoE employs a suite of physical environment related indicators and is the main reporting instrument at both the national and state/territory levels (Commonwealth of Australia 2009).

2.1 Limitations of State of Environment reporting

One of the main criticisms against SoE system is that for it to be effective, the issues included in SoE should also be included in a local government's strategic planning process, earmarked as themes of response strategies. However there is no mechanism in the local government planning processes that allows this to happen.

Most council activities have environmental implications. The SoE system therefore should theoretically have the potential to influence many LGA functions. However, no such link between

the two exists. As a result little progress has been observed in the SoEs leading to the operationalisation of sustainability (see Harding and Traynor 2001, Blair et al 2006, Maganov 2006 for example).

The SoE system has increasingly been recognised as weak in practice (ibid). As a result state and local governments in NSW and Victoria have long been advocating for more holistic tools that inform policy and planning processes along with assessing sustainability (Smith and Scott 2006, and Hurley and Horne 2008). Blair et. al (2006) categorise them under the following five groups:

- 1 Programme organisation: An initial review of operating LGA SoE Programmes (eg North Sydney and Willoughby Councils) highlights that deficiencies in the organisation of programmes can compromise outcomes. Objectives are not tied to the environmental topics and indicators are not matched to objectives, this raises doubts about the value of the monitoring of results. Moreover, there are often no targets which give transparency to programmes. This was reported almost a decade ago by Yenken and Wilkinson (2000). A study of Local Environment Plans in NSW local governments by Gurrans and Phibbs (2009) report the situation has not got any better.
- 2 Limited scope: the Australian SoE system is very narrow. Indicators are few, confined to the physical domain and do not apply to urban environment. Practitioners in local and state government and academics (eg Smith and Scott 2006; Harding and Traynor 2001) have significant doubts about the effectiveness of the SoE system even in its narrow application.
- 3 Sustainability thinking: the SoE system is not integrated with the principles of sustainability that reflects the current thinking and that embraces society, economy, and the environment.
- 4 Functional role: the SoE system generally exists in a strategic vacuum at local government level according to government agencies NSW Department of Local Government, NSW Department of Environment and Climate change, Victorian Commissioner of environment Sustainability and a survey of LGAs carried out the Institute of Public Works Engineering Australia (IPWEA, 2002, Maganov 2006). The situation has not changed much since then. Gurrans and Phibbs (2009) have reported the lack of references to sustainable planning in the statutory documents this year.
- 5 Lack of focus: most SoE reports contain descriptive tracts on environmental planning and management matters, and lack a focus on actions needed to correct perceived problems.

2.2 Industry's response

The industry has felt the need for having a more robust assessment methodology. Evidence can be seen in the plethora of assessment methods and tools developed during the past five years or so. The coming to the scene of VicUrban in Victoria, United Nation's Global Environmental

Outlook, LEED Neighborhood in the US, and several others from local governments, universities, consultancy firms etc can be seen as an attempt to fill the gap.

A preliminary review of some of these assessment methods reveals that:

1. most assessment methods can be classified into three categories:
 - a. checklist type: level of sustainability is assessed by counting the number of 'green' measures taken, and awarding them a score on a scale, eg VicUrban, LEED Neighborhood.
 - b. indicator-performance type: several chosen indicators are measured, and various countries/cities are compared with each other against each indicator. Eg UNEP's DPSIR base Global Environmental Outlook (GEO) and European Common Indicators
 - c. assessment methods for specialised purposes such as communication, building public-opinion etc—eg ecological footprint, BEQUEST
2. There is little consensus on a single approach or method to conduct such assessments. The lack of consensus may be due to one or more of the following (the list is not exhaustive):
 - a. the complexity of interrelationships of environmental subsystems
 - b. an inadequate understanding of the above
 - c. restricted perception of the limits of sustainable use of resources
 - d. lack of certainty about the carrying capacity of ecological systems
 - e. it is not known either what kind of changes will ensure that sustainability will occur
3. significant agreement on the objectives for such an assessment methods can be seen in the form of the following issues:
 - a. problem identification and decision making for its rectification
 - b. quantification of issue affecting sustainability
 - c. measurement of progress of sustainable development, and
 - d. assessment of the impacts of policies.

The above review gives a conceptual overview of the structure and some key issues that underpin these tools. Many studies have critically evaluated their performance. WAPC (2007), for instance, concludes that the sustainability assessments have become commonplace with numerous tools and methodologies being developed to be used in planning; and that "no single tool incorporates a quantifiable system, factors in policy objectives, establishes a process of continuous improvement and thus lacks a comprehensive and universal methodology". [Also see Hurley and Horne (2006) for a review of urban sustainability assessment methods and approaches].

There is enough evidence in the literature to suggest that SoE and other tools currently being used fall well short of their intended aim. Various international bodies such as those functioning under the aegis of United Nation have been advocating in favour of having new assessment

systems; they call for developing indicators and analytical/predictive tools for sustainable development; they stress the need for better methods of data collection and assessment for improved coordination of environmental, social, demographic, and developmental data (see for example UN Department of Economic and Social Affairs 1992 and UNEP 2007). In this professional environment marked by an emerging market 'demand' for sustainability assessment tools, and a lack of 'suitable supply' an integrated sustainability assessment framework is required that addresses the issues identified in SoE and other current urban sustainability assessment systems. It argued here that LESS is able to fill the gaps left by SoE and other approaches to a significant extent.

3. Blueprint of a new urban assessment framework LESS

A new multi-scale and action oriented framework that can be applied to the design of new and operation of existing urban centres (such as neighbourhoods and Local Government Areas), integrated into governments' policy planning for sustainable management of our cities is being developed at HASSELL. Such a framework has the promise to significantly upgrade Australia's urban sustainability assessment and reporting system that largely consists of State of Environment (SoE) framework currently as discussed in section 2. This framework is known as Local-area Envisioning and Sustainability Scoring system or LESS. It is a work in progress. It is envisaged to be completed in three phases:

1. Conceptualisation of system architecture: this phase has been completed and this paper reports on it.
2. Pilot and testing: this phase is currently ongoing. Fairfield LGA and City of Sydney data is being used to test and demonstrate the working of the framework. Results will be available by December 2009.
3. Launch: adjustments based on the Pilot and Testing phase will be incorporated and the framework will be made available for use by June 2010.

Insert Figure 1 here

LESS is a framework or methodology for the integrated assessment of urban sustainability. Integrated assessment as defined by Intergovernmental Panel on Climate Change (IPCC 2005) is a method that combines results and models from physical, biological, economic and social sciences, and the interactions between these components in a consistent framework, to project the consequences of climate change and policy responses to it.

LESS is intended to help develop a better understanding of the issues that are important for sustainability; measure the various aspects of sustainability; set goals for progress, and monitor progress over time. LESS can be used for urban areas, existing or being designed, and evaluate design/policy alternatives.

LESS has been modelled on the 'City Environment Assessment Methodology' (CEAM) developed by United Nations Environment Programme. CEAM's purpose is to "specifically analyse how urbanisation influences the environment through factors that put pressure on natural resources

and urban ecosystems, resulting in a determined state of the environment and its trend — with an impact on the quality of life in cities and that bring specific responses from the local government and society" (UNEP 2007). It is a direct application of Driving forces-Pressure-State-Impact-Response (DPSIR)ⁱⁱ model which is used by UNEP in their flagship international project Global Environmental Outlook (GEO) . The analyses in GEO focus on trends and the pressure of urban development on the environment.

The choice of DPSIR framework as the foundation for LESS was made as it aims to fulfil similar objectives as does LESS. These are:

1. Analyse and assess the sustainability of a range of elements in an urban environment
2. Provide a tangible measurement and assessment to sustainability
3. Create a knowledge-based application that can be used across all disciplines (such as Planning, Urban design, Landscape architecture, Architecture) and projects (such as master planning, structure planning, campus design etc).

In addition to the above DPSIR is an improvement over the PSR (Pressure State Response) on which SoE is based. DPSIR therefore is a logical progression in the evolution of an assessment tool. DPSIR is also being used internationally by the United Nations and European Union and therefore has international and futuristic flavour.

4. The working of LESS: the structure and the process

The working of LESS can be visualised in two distinct components: an outer shell of a generic assessment framework, and an inner core of project specific set of indicators. The outer shell is a combination of a theoretical model DPSIR to systematise indicators, and a scoring mechanism. The inner core on the other hand allows the application of the scoring mechanism on the chosen set of indicators to generate a sustainability index. (See figure 2)

Insert Figure 2 here

The process of using LESS is simple. It involves four steps.

- 1 First step is to align the framework with the theoretical underpinnings of DPSIR model.
- 2 Secondly setup the context and boundaries. This involves reviewing strategic documents and understanding the key components of stakeholder's vision, and compiling appropriate indicators for them.
- 3 Third step is developing an understanding of the study area based on evaluation of the indicators. This involves establishing base case as well as desired benchmarks and weightings for these indicators.
- 4 Final step is creating the report based on analysis and what-if scenarios and generating recommendations for action.

Insert Figure 3 here

5. Building blocks of LESS

This section briefly discusses the basic components and terms that describe the LESS framework. These are:

- DPSIR framework ,
- scoring mechanism
- weightings
- indicators, indices, frameworks

5.1 DPSIR framework

DPSIR provides structure to the collection of indicators used in a sustainability assessment. It provides feedback to policy makers on sustainability issues and the consequences of the political choices made or to be made in the future. DPSIR, used by public bodies such as the United Nations, and the European Environmental Agency, is an improvement over the PSR (Pressure-State-Response) framework currently used by the OECD countries. DPSIR is based on the premise that there is a causal chain of links starting with '**driving forces**' (eg economic sectors, human activities) through '**pressures**' (eg emissions, waste) to '**states**' (eg physical, chemical, biological), and '**impacts**' on human systems, human health and functions, eventually leading to political '**responses**' (eg prioritisation, target setting, indicators) (Kristenson 2004). See table 1 and Figure 4.

Insert Table 1 here

DPSIR also underpins the GEO (Global Environmental Outlook) process, UNEP's flagship internationally implemented integrated urban assessment programme.

Five key questions addressed in the methodology are:

1. What is happening to the environment and why? (state, pressure, driving force)
2. What are the consequences for the environment and humanity? (impact)
3. What is being done and how effective is it? (response)
4. Where are we heading? (future outlook)
5. What actions could be taken for more sustainable future? (policy options)

These questions relate to the different processes analysed in the City Environment Assessment Report, including devising future outlooks for the local environment together forming an integrated environmental report that goes beyond usual methods of assessing the state of the environment. An integrated report means process of producing and communicating information on interactions, the point where the natural environment and society meet , so as to produce a systematic view of the determining factors and of the processes that result from the interaction between the cities and the environment (UNEP 2007).

Insert Figure 4 here

4.2 Scoring

The scoring mechanism is fashioned on the NSW BASIX model (See Planning of Planning NSW 2009) which compares current/estimated performance of buildings with respect to water use and green house gas (GHG) emissions to assess if the targets are met. LESS scoring works on the same principle. An observed value of a chosen indicator is compared with the chosen benchmark/target (which is arrived at in consultation with stakeholders) to assess how far it is from the target. An indicator score is computed by subtracting observed value from the benchmark/target value and dividing by the benchmark/target value. The resulting number is a ratio-index. In statistical terms this technique is referred to as standardisation/normalisation. Standardisation removes the difference in the units of various indicators and brings them on the same scale, in this case from 0 to 10.

Global Reporting Initiative (2009) recommends the use of ratios or standardised/normalised data for presentation. It is however stressed that in such cases "absolute data should also be provided". Such indices have been used evaluating indicators in diverse fields such the Legatum Prosperity Index (Legatum Institute 2008), Cities Liveability Index (The Economist 2007).

4.3 Weighting

Weighting is an important part of any integrated assessment process. All criteria being assessed cannot be of equal significance. Establishing weighting is a contentious process. The following two approaches are adopted to deal with the contentious nature of the issue:

1. encourage local governemtns/stakeholders to generate weightings from their internal processes.
2. in cases where consensus is difficult to achieve best, worst, and median case scenarios can be created (high, low and medium weights). Results can be reported in all three cases for client to consider.

A negative sign is assigned to all weighting for disadvantage indicators. This is an accepted statistical practice as also adopted in Socio-Economic Indicators For Areas (SEIFA) computed by the Australian Bureau of Statistics (ABS 2006).

4.4 Indices, indicators and frameworks

Indices are aggregated statistical figures that express a relationship, scale or value in comparison to a previously established number. 'All Ords', for example, is an index of the daily change in share prices on the Australian Stock Market based on the average price in the shares of selection of top Australian companies. It is a number (eg) which does not have a unit or does not convey any meaning unless its context is understood.

We all use indicators to "monitor complex systems we care about or need to control". We use different words to refer to indicators in our daily lives such sign, symptom, Signal, tip, pointer, warning light, instrument, measurement data etc. Some examples of indicators we are familiar with: mothers observe activity level of their children, the way they breathe in sleep; doctors take temperature and test blood; economists use cost-of-living, Dow-Jones, GOP etc; and the legendary indicators: the canary in the coal mine, the seagull that Signals the yet invisible land, and the puff of smoke from the Vatican chimney!(Meadows ·1998).

Sustainability indicators provide feedback on the overall health of our community and are an effective way of describing and documenting the urban performance characteristics. To measure and monitor the emerging trends in urban development information relating to different aspects of the state of urban environment must be collected, collated in appropriate format. This is vital for awareness among the community, decision makers and professionals alike.

Some thoughts culled from Meadow (1998) one of the most cited treaties on the subject:

1. choice of indicators is critical, poorly chosen indicators can cause problems;
2. indicators are only partial reflections of reality--based on imperfect t models; despite their difficulties and uncertainties we cannot manage without them; the search for indicators is evolutionary--the necessary process is that of learning;
3. sustainability indicators must be more than environmental indicators--they must be about time and/or thresholds; development indicators should be more than growth indicators-- they should be about efficiency, sufficiency, equity, and quality of life;
4. its not easy to find ideal indicators; most of us have indicators in the back of our minds-- its important to bring them out on the table; to inform :sustainable development reporting on just indicators is not enough--a coherent information system is needed fmm which information can be derived; the indicator selection process works best with a combination of expert and stakeholder participation, must be done with care.
5. Indicators don't guarantee results, but results are impossible without proper indicators; indicator measurement can be costly but if cleverly done can be simple; the process of finding and developing sustainability indicators may not be perfect the first time, "nevertheless it is urgent to begin" .

Frameworks are methodological statements akin to assessment systems or mechanisms that define relationships between the various components of an urban system/environment. Frameworks aim to devise ways to characterise cities and help unearth the correlates of why the city is how it is and how it is evolving over time (Prasad, Jianyu 2007). LESS has been conceived as a framework. It establishes a method to record indicators, classify them, set goals/thresholds and weights, allow scoring and aggregating the scores for a composite, integrated picture of the area examined. This framework can be used to generate a customised method/tool for assessment of an area of interest by selecting indicators appropriate for the area and goals as desired by the stakeholders.

Insert Figure 5 here

5. Outcomes of LESS

LESS aims to fill the gap in demand by establishing a 'unique reference framework' by combining social, economic, and environmental data along with relevant indicators systemised in a conceptual model like DPSIR, benchmarks and assessment protocols.

In this section the weakness of SoE system as listed in Section 2 are revisited and analysed how they are overcome with using LESS.

SoE Weakness1 Programme organisation: LESS allows organisation of custom built programme of assessment. The issues to be assessed are chosen as per the sustainability objectives and only those indicators are chosen for assessment that have direct relevance to the objectives and issues of interest.

SoE Weakness 2 Limited scope: LESS does not recommend a fix list of indicators; depending on the availability of resources an unlimited number of indicators can be chosen for assessment.

SoE Weakness 3 sustainability thinking: LESS philosophy is in line with the current sustainability thinking. Unlike SoE LESS includes indicators from social, economic and environmental domains. Indeed other domains such as infrastructure, governance etc can be included for assessment as per requirement.

SoE Weakness 4 Functional role: The framework fits well within the local government decision making process which involves the decision maker using the outputs from LESS for their policy, which upon implementation generates feedback from community which is taken into account and priorities and issues are revised in the next round of assessment. The process is iterative and universally followed. See figure 6

Unlike SoE the basic organisation of LESS framework sits within in the strategic objectives of an urban development (eg an LGA). The issues to be assessed come from vision documents (such as Sydney 2030 document of Sydney LGA) or community consultation. LESS allows the selection of target as an absolute value adopted from another city or country (such as a local government might want to achieve same length of cycle track per

sq km as in Denmark which is about 250m per sqkm) or a relative value (such as 2% decrease in suspended particles in air for next five years). Progress can then be tracked and fed back to the management plan for further action.

Insert Figure 6 here

A multidisciplinary, interlinked assessment approach as described above that is sensitive to the global impacts of local activities and vice-versa: in other words an assessment system which could combine, interpret and communicate items of knowledge from diverse disciplines in such a way that insights are made available to stakeholders, can go a long way towards not only fulfilling the gap left by SoE reporting and other assessment systems but also meeting the market demand.

The following table compares the existing assessment methods and LESS with respect to the market expectation with regards to urban sustainability assessment.

Insert Table 2 here

6. Conclusion

Assessment of urban sustainability, an important step in the pursuit of sustainable development, is a contentious issue due to, among other reasons, its multidisciplinary nature and multiple stakeholder interest. LESS a next generation assessment framework, not only allows mapping, measuring and monitoring sustainability of urban areas but also enables developing a thorough understanding of the study area. LESS promises to resolve some issues that have been observed in the current urban sustainability assessment methods, particularly the SoE.

It allows the understanding of strengths and weaknesses and tradeoffs between the various components of an urban system and functions as a diagnostic tool. It takes into account overall impact on the environment and doesn't merely rely on counting 'green' measures. The impacts of disparate activities can be visualised on a single scale. There is complete transparency with regards to the scoring mechanism and all assumptions.

One of the main limitations of LESS lies in its inability to be used as 'off-the-shelf' product, unlike several other assessment methods that allow quick assessment based on a predefined set of indicators. LESS is intended to be developed as an 'urban model' for local governments and precinct/neighbourhood developers, scope and limits of which need to be developed in close coordination with stakeholders. This can sometimes be a time consuming exercise. This also means that the assessment model needs to be set up by experts before it can be used by stakeholders, unlike some others that can be considered as do-it-yourself tools.

Next steps as identified for the future development of the framework involve a quick completion of the Pilot and Testing phase and subsequently making it available to local governments for use. Both these steps would include independent scrutiny from experts.

Given the significance of sustainability assessment in sustainable urban development it is hoped that LESS will be able to provide not only an assessment and diagnostic tool but also an ongoing resource for developing benchmarks, sustainability targets, and a repository of sustainability indicators for Australian cities.

5. References

ABS. (2006). *Socio-Economic Indexes for Areas (SEIFA) - Technical Paper*. Australian Bureau of Statistics. Canberra.

Department of Planning NSW. (2009). BASIX. viewed 20 May 2009. www.basix.nsw.gov.au.

Blair J, Prasad D, Varshney A, (2006) *Securing Sustainability: developing an integrated management tool for Australian cities* –A research proposal submitted to Australian Research Commission. Faculty of Built Environment, UNSW. Sydney.

Commonwealth of Australia. (2009). *State of the environment (SoE) reporting*, Viewed 15 August 2009. <http://www.environment.gov.au/soe/>

European Common Indicators. (2003). *Development, refinement, management, and evaluation of European Common Indicators Project (ECI)*. Ambiente Italia, Milano.

Girardet, H. (2003). *Creating sustainable cities*. Green Books. Devon..

Global Reporting Initiative. (2006). *GRI Sustainability Reporting Guidelines, version 3*. Global Reporting Initiative.

Gurran N, Phibbs P. (2009). *Planning for sustainable cities and regions: an audit of local environmental plans*. in NSW in State of Australian Cities 2009 Conference November 2009 Perth.

Harding, R., Traynor, D. (2001). *Informing ESD: State of the Environment Reporting* in "Processes and Institutions for Resource and Environmental Management: Australian Experiences (final report to Land & Water Australia), edited by Dovers S, and Wild River, S, CRES ANU, Canberra.

Holdren, J. P., Daily, G. C. and Ehrlich, P. R. (1995). *The meaning of sustainability: biogeophysical aspects*. viewed 18 March 2004, <http://dieoff.org/page113.htm>.

Kristensen P. (2004). *The DPSIR framework, assessment of the vulnerability of water resources to environmental changes in Africa*. UNEP Nairobi.

Hurley, J. & Horne, R. (2006). *Review and Analysis of Tools for the Implementation and Assessment of Sustainable Urban Development*. In Environmental Institute of Australia and New Zealand National Conference, 17- 20 September 2006 (pp. 165-174). Adelaide: Environment Institute of Australia and New Zealand.

IPCC. (2007). *Fourth Assessment Report: Climate Change 2007*. Intergovernmental Panel for Climate Change.

IPWEA. (2002). *Analysis of the state of the environment questionnaire*. Institute of Public Works Engineering Australia, Sydney.

Jones, D. L. (1998). *Architecture and environment; bioclimatic building design*. Laurence King. London.

Legatum Institute. (2008). *The 2008 Legatum Prosperity Index Report*. Legatum Ltd Dubai.

- Maganov P. (2006). *SoE what?* Viewed septemebr 2009.
http://www.griffith.edu.au/data/assets/pdf_file/0019/81370/environmental-city-06-maganov.pdf
- Meadows, D. (1998). *Indicators and information systems for sustainable development*. The Sustainability Institute, Hartlans.
- Prasad D, Jianyu Z. (2007). *Shanghai Environmentally Friendly City Initiative* a report Prepared for Shanghai Environmental Protection Bureau In co-operation with the United Nations Development Program (Beijing). Faculty of the Built Environment, UNSW, Sydney.
- Rees, W. (1999). The built environment and the ecosphere : a global perspective. *Building Research and Information*, Vol 27, 4/5:206-220.
- Smith G, Scott J. (2005). *Living cities an urban myth?* Eosenberg Publishing. Sydney.
- The Economist. (2007). *Liveability Ranking*. viewed February 2009.
http://www.economist.com/markets/rankings/displaystory.cfm?story_id=8908454.
- UN Department of Economic and Social Affairs. (1992). *Agenda 21*. New York.
- UNEP. (2007). *Global Environment Outlook GEO4 environment for development*. United Nations Environment Programme, Nairobi.
- USGBC. (2009). *LEED for Neighbourhood Development* viewed March 2009.
<http://www.usgbc.org/DisplayPage.aspx?CMSPageID=148>.
- Valentini, V. (2001). *GIS for sustainability assessment*. Directorate general for research-directorate A, Luxembourg.
- VicUrban (2009)
- Wackernagel, M. and Rees, W. E. (1996). *Our ecological footprint reducing human impact on the earth*. New Society, Philadelphia Pa.
- Marker B. (2005). *Sustainable Minerals Operations in the Developing World*. Geological Society Special Publication.
- WAPC (2007). *A review of assessment tools and approaches* Western Australia Planning Commission, Perth.
- Varshney A Kumar. (2006). *Towards an Integrated Sustainability Assessment of the Built Environment: The Convergence of Ecological footprint and Spatial Analysis to Map the Urban Dynamics of a City*. PhD dissertation, UNSW Sydney.
- Varshney A K. (2009). *LESS A theoretical and operational overview, position paper*, unpublished report. HASSELL Library, Sydney.

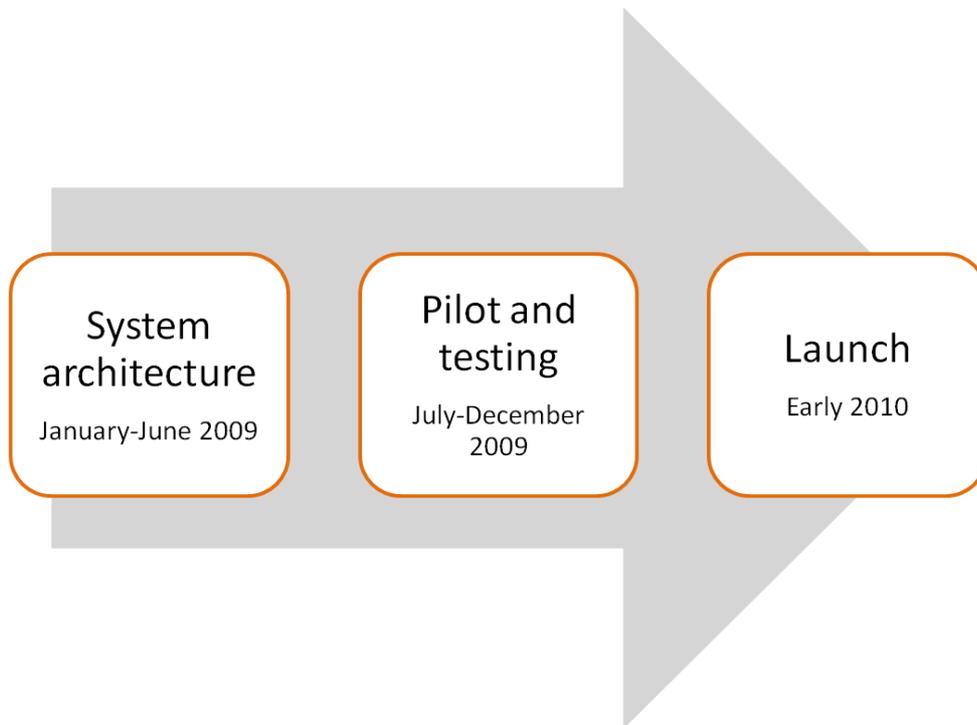


Figure 1 LESS project programme

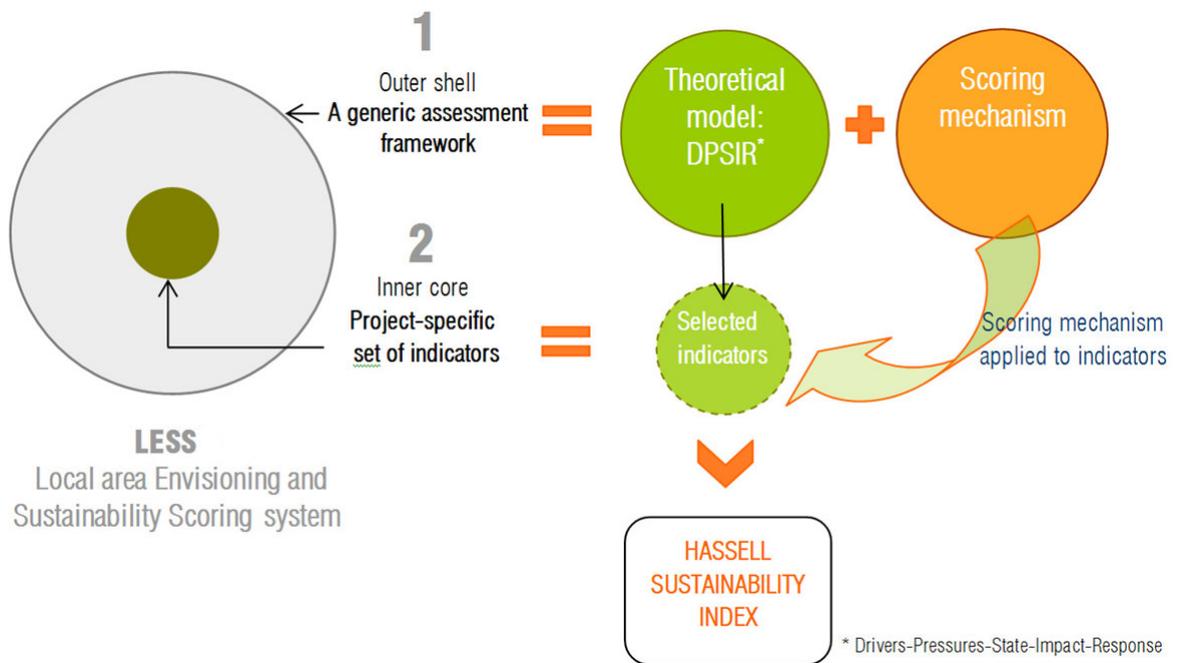


Figure 2 Basic structure of LESS

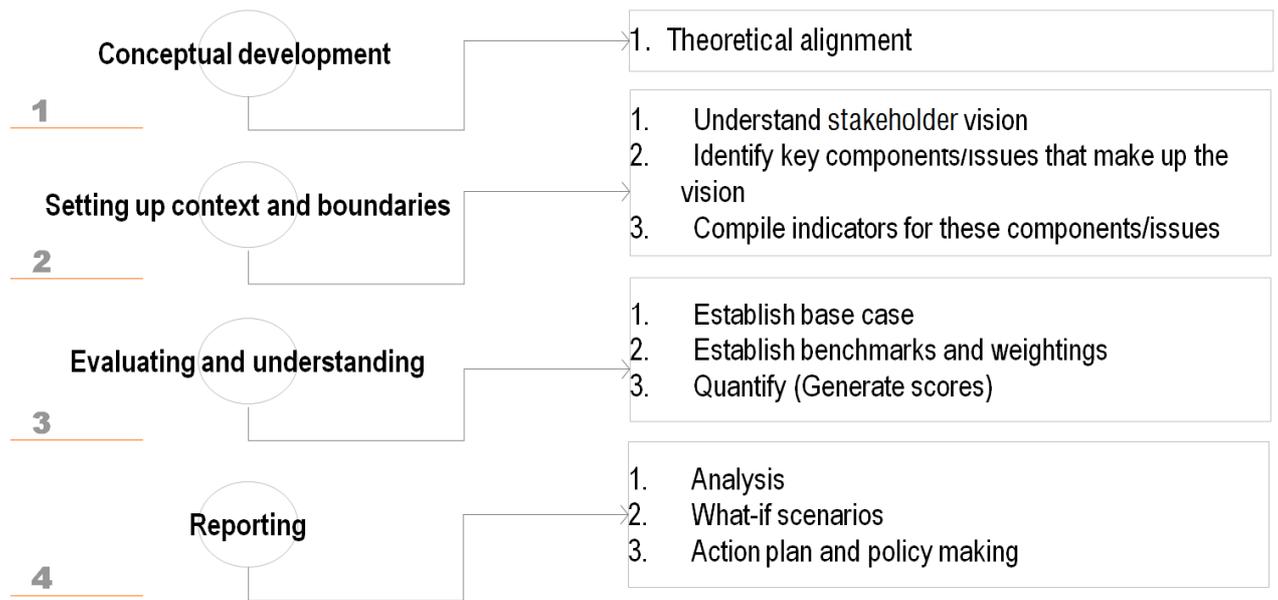
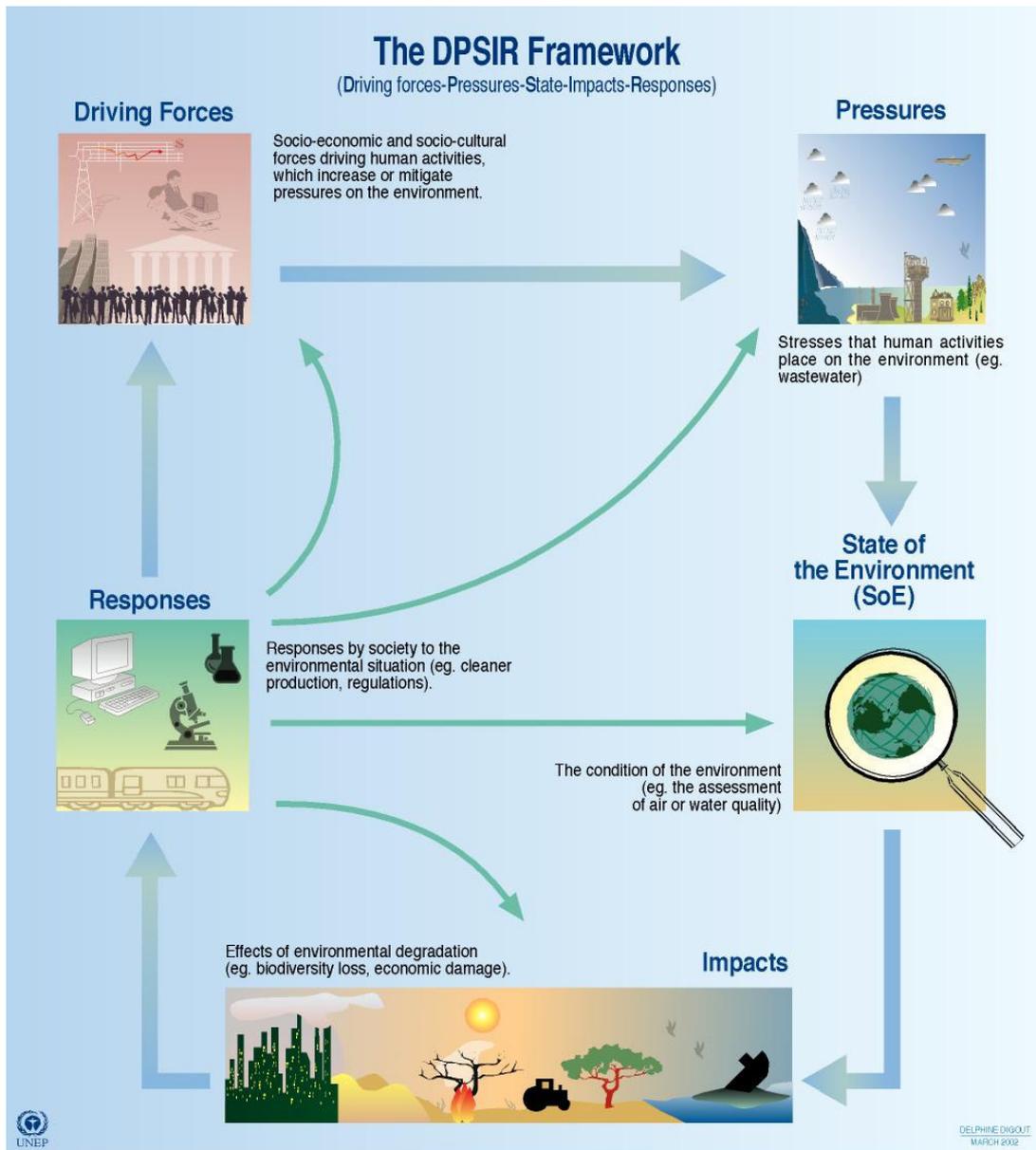


Figure 3 Workflow in LESS



Source : Global International Water Assessment (GIWA), 2001; European Environment Agency (EEA), Copenhagen.

Figure 4 Driving forces-Pressure-State-Impacts-Response model explained

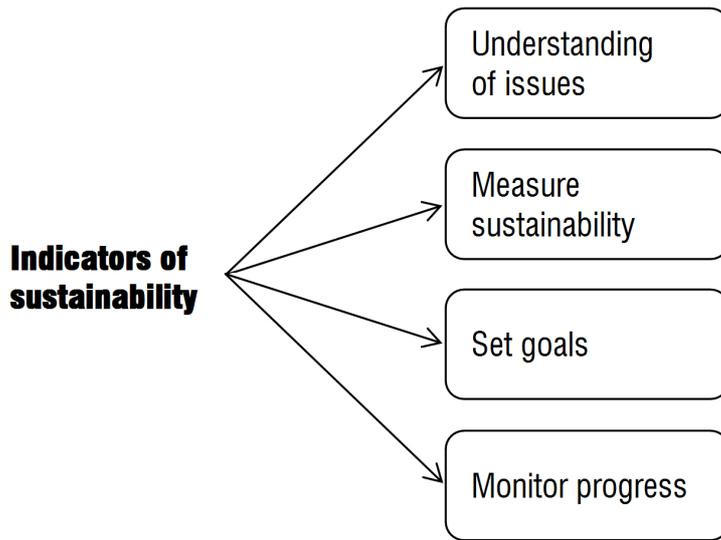


Figure 5 What can be achieved with indicators of sustainability

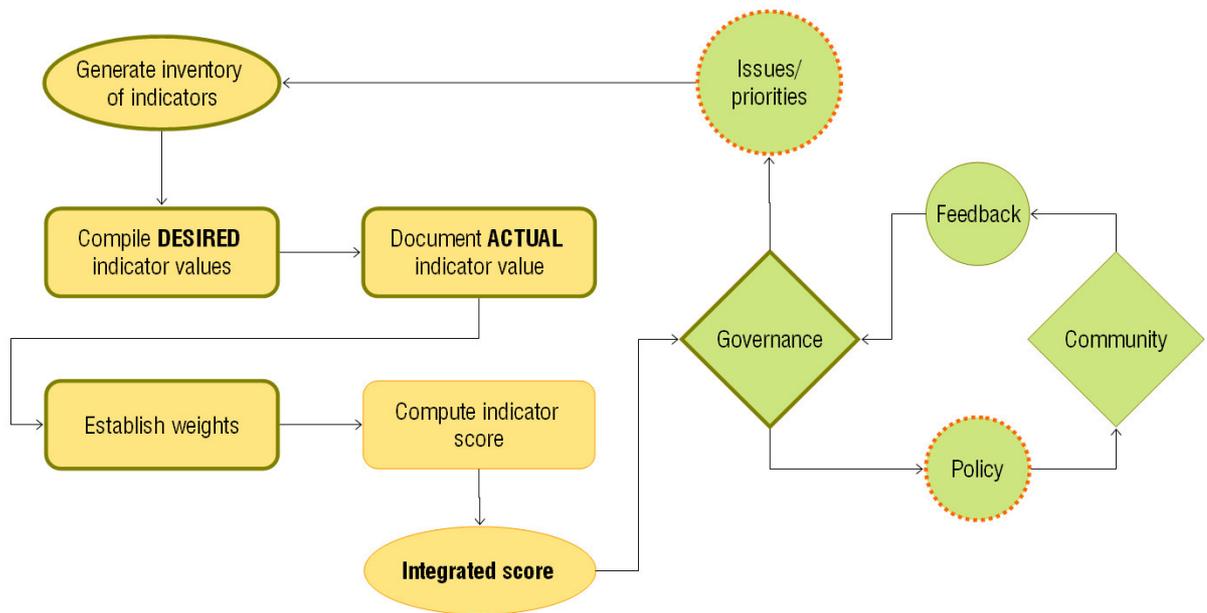


Figure 6 LESS and the decision making framework of local governments

Table 1 Characteristics of the DPSIR matrix indicators (source UNEP 2007)

| | |
|---------------------|---|
| PRESSURE INDICATORS | Describe what caused the problems on which the local government and society must act to preserve and improve the environment. |
| STATE INDICATORS | Describe the conditions and quality of the local environment. Show how human pressure in urban development affects environmental quality and the quantity of available resources. These indicators are used to formulate public policy on the problems detected. |
| IMPACT INDICATORS | Designed to uncover how the state of the environment affects different human interests, such as quality of life, urban economy, ecosystems, urban vulnerability as well as on the political-institutional level. |
| RESPONSE INDICATORS | Allows an assessment to be made of the improvement, protective, limitation and regulatory measures taken by the local government, civil society bodies, and enterprises or by individuals, to deal with environmental problems, particularly those relating to human pressure on environmental resources. |

Table 2 A qualitative comparison of LESS with existing urban sustainability assessment methods

| | User expectationⁱⁱⁱ | Gaps left by the current supply of assessment methods^{iv} | How LESS fills the gap |
|---|--|---|---|
| 1 | <i>Result orientation</i> | Checklist type methods encourage 'ticking the box' approach—more boxes ticked results in better rating. | The focus is on the result—performance is compared against targets |
| 2 | <i>Objective assessment</i> | Score is often based on subjective evaluation of the assessor(s)—eg 6 on a scale of 0 to 10 | Score is based on actual performance and benchmark/targets |
| 3 | <i>Integrated approach</i> | Indicator-performance type methods assess each indicator independently | Indicators can be combined into a unified index to give an aggregated picture using the multi-criteria analysis method |
| 5 | <i>Flexibility and customisability</i> | Most current assessment methods have a fixed list of indicators to be assessed—irrespective of stakeholder requirements (eg water may be a priority issue in WA but not in Tas) | LESS allows to take into consideration only issues that are relevant to stakeholder; allows to devise new indicators/proxy indicators to replace certain indicators that are expensive to measure |
| 6 | <i>Dynamic nature of analysis</i> | Allow only static assessment, ie you can obtain results on in a predetermined format | LESS allows to analyse finer issue/subcategories dynamically: once all the indicators are in place, customised analyses can be conducted to identify and locate problems(diagnose), eg all 'Impact' and 'Response' indicators relating to 'water' can be analysed to see if the govt 'response' matches the impact level on water issues. |
| 7 | <i>Goal setting</i> | Difficult to goal set in checklist type; | Goals setting possible—depending on current performance and aspirational |

long term target (say for 20 years) annual targets can be established.

ⁱ Environmental impact is generally acknowledged to be any change to the surroundings in which a city exists, including air, water, land, natural resources, flora, fauna, humans, and their interrelations, whether adverse or beneficial, wholly or partially occurring as a result of design, construction, operation or demolition of built environment.

ⁱⁱ DPSIR has been explained in section 5.1

ⁱⁱⁱ Source: Varshney 2006

^{iv} Source: Varshney 2009