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MONITORING A CITY: EXPLORING SUSTAINABLE-DEVELOPMENT INDICATORS FOR EUROPEAN CITIES

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Abstract

The use of indicators to measure urban sustainability is highlighted in Agenda 21 and has been emphasised as an important instrument at many of the European Conferences on Sustainable Cities and Towns. This study is an explorative analysis of eight European cities to determine what aspects of sustainable development are measured, what reasons are given for using indicators to measure urban sustainability, and to what extent uniformity has been included in indicator design. The most striking findings may be that the indicators were not equally distributed across aspects of sustainability and that almost all of the 332 identified indicators were differently defined. Further, a pressure–state–response (PSR) analysis revealed that most indicators focused on the state aspect.

Keywords

Indicator design, Sustainability indicators, City, PSR model, Urban.

Contents

Introduction

In Europe, as elsewhere in the world, populations have become increasingly urbanised. Europe is one of the most urbanised continents in the world, with nearly 75% of the population living in cities and more than 25% of the European Union's land consisting of built-up areas. The urbanisation process is still ongoing: it is estimated that, in 2020, 80% of Europeans will live in cities. What is more, historical studies show that, since the middle of the 20th century, the area of European cities has expanded by an average of 78% while their population has grown only by an estimated 33%, meaning that the urban areas have become less compact (EEA 2006). Demand for land in and around cities will therefore increase (EEA 2006; EEA 2010). There is pressure on urban planners not only to make cities attractive, but also to provide a good living environment and minimise health risks stemming from air pollution and noise. More holistic evaluation and assessment perspectives developed in recent decades, such as ecological footprints, commodity chains and life-cycle analysis (LCA), have made it evident that the environmental effects of urban life reach far beyond city limits. One uncomfortable example of this is coltan, a conflict mineral which is used in computers and thus creates a link between the conflict in Congo and computer users around the world.

Today, sustainable development is a common policy goal worldwide, and several collective efforts have been made to achieve sustainable societies. However, despite near-universal recognition that sustainable development is a desirable goal, there is an obvious lack of consensus and certainty about the exact meaning of 'sustainability' in practice (Bulkeley and Betsill 2005; Owens 2003; Redclift 2005; Swyngedouw 2007). Our diverging views – even ignorance – of what constitutes a sustainable city make it hard to know whether such an entity is even possible (Gibbs 1999). In fact, sustainable development is a concept that has an array of meanings and is characterised by a complexity that makes it difficult to put into practice. Guy and Marvin (1999, p. 269) say that 'within the sustainable-cities debate, a diverse and expanded group of social interests can be identified, each developing competing visions of what a sustainable city might become'. It is also often argued that sustainable development demands an integrated approach reflecting the diversity of issues involved as well as multiple scales in space and time (Dimitrakopoulou & Giaoutzi 2003). Sustainability has been described as a moving target in that it changes in relation to time and space and also depends on knowledge production, new technologies and varying human values. Sustainable development could thus be described as 'a journey rather than a destination' (Mega 2000, p. 227), meaning that we will always have to define and redefine the concept.

One way to measure the sustainability of cities is to use sustainable-development indicators (SDI). In fact, indicators were included in the original formulation of the sustainability concept: according to Chapter 40 of Agenda 21, indicators of sustainable development need to be developed to provide solid bases for decision-making at all levels and to contribute to a self-regulating sustainability of integrated environment and development systems.

It is therefore natural that public administrations should use urban indicators to underpin their sustainable-development strategies. As Innes and Booher (2000, p. 174) write, '[w]hile there remain disagreements about how to define, much less to reach, a sustainable society, there seems to be agreement that indicators will play a key role'. However, as Tanguay et al. (2010) point out, despite the popularity of SDIs there are problems with using them since the universal definition, while politically expedient in terms of achieving global acceptance, is vague and open to different interpretations. In their study, they showed that there was indeed a lack of consensus regarding the conceptual framework as well as the selection and optimal number of indicators, which they ascribed to the ambiguity of the concept of sustainable development and the various objectives for the use of indicators. What are those potential objectives? An obvious objective of any indicator is to show changes in a phenomenon and thereby guide decisions so that decision-makers can choose means by which to reach selected ends. But an indicator may also influence decision-makers through its capacity to function as a 'flag' for further investigations to be followed by actions (Holden, 2006). In this context, an indicator can actually be qualitative as well as quantitative. Others argue that indicators should not only be used in institutional public decision-making but should also be intended to make sense to the public and to change public behaviour so that it becomes more environmentally friendly.

Innes and Booher (2000) claim that there is no formula or simple strategy to use when developing indicators. These will depend on local context, culture, issues, actors and institutions, which makes it difficult to copy indicators from one city to another. Others, like Tanguay et al. (2010), put forward several arguments in support of the view that there ought to be *some* consistency among cities with respect to the design and number of indicators. Their arguments are, first, that sustainable development should not be systematically redefined when adapted to a particular territorial context and, second, that it should be possible to make fair comparisons between cities of the same size, even if local conditions are taken into account to some extent. According to Tanguay et al. (2010) this will reduce the risk of cities choosing only those indicators that will make them look good.

This leads to the question of how sustainable development is understood in an urban context and how it is measured through indicator sets. Our aim in this study is to explore how urban sustainability is framed in indicator design and what reasons are given for specific designs. This will contribute to the discussion of how to develop urban-sustainability indicators. It may be added that indicators are sometimes developed in relation to local context and policies, and in the framework of collaborative learning processes. Such learning processes (if any) are not investigated in this study. Nor do we try to analyse effectiveness, that is, the link between indicators and decision-making at the neighbourhood or city-authority level. Rather, we try to find general patterns in how cities choose to measure urban sustainability using indicators and thereby explore how urban sustainability is framed. The study has been performed to explore and illuminate the following questions:

1. What are the explicit reasons given for developing the specific sets of indicators?
2. What aspects (economic, ecological, social or cultural) and sub-categories of sustainable development are addressed in the indicator sets, and to what extent?
3. Is there any uniformity in indicator design across cities?
4. How are the indicators distributed among the categories of the PSR model (pressure, state and response)?

Examples of different approaches to the development of indicators

An indicator represents and simplifies a phenomenon, helping us to understand a complex reality. Indicators can be used for different areas and at various spatial scales – at global, national, regional and local level. Indicators can also be aggregated into an index, such as the Human Development Index created by the UNDP. One fairly common approach is to require that indicators should meet a number of criteria referred to as SMART: Specific (clear and concise), Measurable (quantitative), Achievable (set objectives capable of achievement), Realistic (reasonable within budget and time) and Time-framed ('completed' by a certain time). However, there is an inherent problem here which must be considered: there is a contradiction between, on the one hand, the idea that sustainable development involves using a holistic approach to grasp humankind's complex inter-relationships with nature and, on the other, the assumption that this can be done using reductionist and quantitative tools such as indicators.

Different approaches have also been developed to address problems with indicator design. Tanguay et al. (2010) used a *survey-based* approach to select sustainable-development indicators by (1) choosing the most-cited indicators; (2) covering the various components of sustainable development; and (3) choosing the simplest indicators to facilitate data collection, understanding and dissemination. Another approach, which was used in Vancouver, Canada, used a combined (or *multi-pronged*) expert-based and citizen-based approach intended to ‘test public awareness-raising potential and motivation potential of an indicators-based approach to sustainable development’ (Holden 2006, p. 177). On this view, an indicator aims to change public actions rather than to measure driving forces or states.

Innes and Booher (2000) divide indicators into four types. The first is the all-purpose indicator produced by experts, by collaborative community-based groups or by some combination of these. The second type is an indicator that sums up the quality of life in one value, that is, an index. The third type of indicator addresses specific problems such as unemployment or crime. The fourth type focuses on measuring the performance of government, similarly to a customer-satisfaction indicator. In the last case, dialogue is emphasised in the development of the indicators. Innes and Booher also point out a number of problems. Indicators in the first category are seldom influential and there is a risk that they will end up on a shelf gathering dust. In addition, these indicators are enormously expensive to develop. The aggregated approach represented by the second category seldom creates anything meaningful, since the indexes often combine so many different values – such as air quality and housing prices – and have an unclear weighting system. This is why indexes rarely influence policy-making or the allocation of funds (Innes 1990).

The challenge is to develop indicators that are meaningful and make a difference: indicators that affect policy and people’s behaviour. To do this, Innes and Booher (2000) suggest, indicators must be developed according to *complexity theory*, which assumes that the city is not a machine but rather resembles an organism that is constantly growing and is affected by the millions of decisions taken by its inhabitants each day. With complexity theory as their point of departure, Innes and Booher propose that there should be three tiers of indicators: (1) a small number of system-performance indicators that reflect central values (e.g. people’s perceptions and attitudes, as determined through surveys); (2) policy and programme indicators that reflect the outcome of various elements of the system (e.g. length of waiting list for public housing); and (3) rapid-feedback indicators that are directed towards individuals, agencies and businesses (e.g. cost of electricity per hour). Finally, Levett (1998) suggests that the sustainability model consisting of three rings (Environment, Ecology, Society) ought to be replaced by a *Russian-doll model*. His argument is twofold: the environment is a precondition for the other two, and the economy is not an end in itself but a social construction that means something only because we think that it will be good at meeting our needs. He concludes that indicators therefore ought to address only two questions: Are we living within environmental limits? and Are we achieving a good quality of life?

Even so, the sustainability paradigm is complex and value-based. This makes it even more important that the indicators used to measure urban sustainability are strict and sound. Many indicators in fact do not really measure the phenomenon they are intended to measure. Levett (1998) gives several examples of poor indicators. For example, he questions whether a reduction in pedestrian and cyclist casualties means that roads are becoming safer or whether it means instead that non-motorists are too terrified to use them. Other risks are that indicators may be manipulated, such as when hospitals shorten waiting lists by moving patients between teams and lists by reclassifying them, or that an indicator may be discontinued when the trend turns negative and this might be seen to reflect poor management and decision-making.

The design of indicators sometimes involves the use of a PSR (pressure, state, response) model or the later version, DPSIR (driving forces, pressure, state, impact, response). The PSR model was first developed by the OECD in the late 1980s and is commonly used to identify and develop indicators. It has been used on everything from catchment systems to gated communities in South Africa (Walmsley 2002; Landman 2007). More specifically, the P of the PSR model represents anthropic pressure on the environment, such as pollutants; S represents the resulting state of the environment; and R represents the reactions or responses to these environmental problems, such as political actions or changes in behaviour. In the DPSIR model, the driving forces (D) could be the transport sector, the financial market and industry, which eventually have an impact (I) on human health and ecosystems.

One problem shared by both of these models is that they can force each category of indicators (transport, energy, etc.) to be broken down into indicators of pressure, state, impact, etc., thus tripling or quintupling the number of indicators. According to Tanguay et al. (2010), this was part of the reason why the United Nations abandoned these models in 2006. Another argument against them is that there is no indication that sustainable development will be better represented by a large number of indicators. Even so, these models can help enhance our understanding of the design of indicator sets by highlighting the amount of focus on specific aspects.

Urban sustainability and indicators

According to one definition of urban sustainability, a sustainable city is ‘one which succeeds in balancing economic, environmental and socio-cultural progress through processes of active citizen participation’ (Mega and Pedersen, 1998, p. 2). One way to understand what a sustainable city is may in fact be to describe an *un*sustainable city. Earlier studies have identified a number of critical aspects, including environmental aspects such as poor air quality, growing automobile use, noise and scarcity of quiet areas, urban sprawl, greenhouse-gas emissions, generation of waste and wastewater, and loss of indigenous landscape and ecosystems; and social aspects, such as crime, social alienation and rising inequities (e.g. Bithas and Christofakis 2006; Wheeler and Beatly 2008).

The First European Conference on Sustainable Cities and Towns took place in Aalborg, Denmark, in 1994. The local and regional authorities attending the conference produced and signed the Aalborg Charter, which is to date the most well-known policy statement for local sustainable development. Signing the Aalborg Charter means committing to a strategy for local sustainable development, including the planning and implementation of a local Agenda 21. The Charter inherited the spirit of Agenda 21 and the commitments set out at the 1992 UN conference, and the Aalborg Charter highlights the importance of sustainable indicators in a section on 'Instruments and Tools for Urban Management towards Sustainability'.

The Second and Third European Conferences on Sustainable Cities and Towns, respectively held in Lisbon, Portugal, in 1996 and Hanover, Germany, in 2000, both had very clearly defined goals. The Lisbon Conference aimed to translate the commitments of the Aalborg Charter into practical measures. As for the Hanover Conference, its sub-title was 'The most significant stocktaking of local sustainability Europe wide: Lessons learned and future directions at the turn of the century'. Accordingly, the conference focused on sharing experience and good practices as well as on pushing further the implementation of local sustainability. The reports from both conferences – the Lisbon Action Plan and the Hanover Call – emphasise the importance of the design and long-term use of local sustainability indicators. A second task of the Hanover Conference was to prepare the Fourth European Conference on Sustainable Cities and Towns, also called Aalborg +10, which was held in Aalborg in 2004. While not explicitly mentioning indicators, the resulting document, called the Aalborg +10 Commitments, establishes the Aalborg +10 baseline reviews, intended to present the actual situations of local communities. It is stated that sustainability targets must be chosen and that the local communities are required to select indicators enabling them to report regularly on their progress. In this respect, the Aalborg +10 Conference places a great deal of importance on indicators.

The Fifth European Conference, held in Seville, Spain, in 2007, confirmed this very important place given to sustainability indicators but in a different way. The conference report, called 'Spirit of Seville', was a very short press release, about 300 words long, but it still makes a point of reaffirming that the communities having signed the Aalborg Charter are to set indicators. Finally, the most recent European Conference on Sustainable Cities and Towns, held in Dunkirk, France, in 2010, coincided with the European Union's work to define its strategy for 2020 and therefore focused on ideas and suggestions about what could be done about sustainability and local governance.

Method

As our study was intended to focus on European cities, we chose the signatories to the Aalborg Charter as the starting point for our work to identify sustainability-indicator sets. Our first step was to scan all baseline reports (baseline reviews), but it turned out that almost none of these reports included indicator sets. We therefore conducted an Internet search for indicator sets using search words and phrases such as 'sustainable cities indicators', 'sustainable indicators', 'municipal sustainable indicators' and 'Agenda 21'. This was done in the autumn of 2009. The search yielded 18 European cities capable of presenting a list of indicators related to urban sustainability. Among these cities, eight had well-defined (i.e. measurable) indicators. Since they also represented a reasonable geographic distribution across Europe, they were selected for further analysis. These cities are Ancona (Italy), Barcelona (Spain), Hanover (Germany), Birmingham and Coventry (United Kingdom), Helsinki (Finland), Linköping (Sweden) and Riga (Latvia).

We also wanted to know about the reasons given for developing the indicator sets. When no reason was stated in the documents we had found, contact persons within the respective city administration were asked specifically about this. No in-depth investigation of reasons (or motives) was made since our aim was to illuminate the existing reasons given.

Further, an analysis of our indicator sets was performed according to the PSR (pressure, state, response) model, which is described below. However, it should be emphasised that it is sometimes difficult to categorise an indicator, meaning that any analysis of the present type will involve an element of uncertainty.

Urban indicators in eight European cities

Reasons

Before describing the indicator sets used in the eight cities, we will briefly discuss the reasons put forward for developing the specific indicators. As described above, Holden (2006) asserted that indicators ought to have a potential to raise public awareness, and Innes and Booher (2000) want indicators that affect both policy and people’s behaviour. We found that the reasons put forward could clearly be divided into two categories: those linked to internal use, i.e. governance, and those linked to external use, i.e. aiming to change people’s behaviour. ‘Governance’ is here understood as an ambition for the city to measure, evaluate and improve management. This ambition may manifest itself in different ways, such as efforts to gather information, to create a standard reporting system or to make sustainable development measurable and assessable, but also in efforts to analyse data and facilitate decision-making. The other category includes indicators developed for external, citizen-oriented uses: to inform, raise awareness and encourage action. This means that, in many cases, the purpose of indicators is not only to collect data in order to analyse trends, but also to communicate with citizens and the media, and to affect people’s behaviour. Of our eight cities, all put forward internal reasons whereas only three (Barcelona, Coventry and Linköping) gave external reasons involving aims such as raising awareness and encouraging action. The study did not include any attempts to describe or analyse how the reasons given affected the design or distribution of indicators, because it is difficult to determine whether a specific indicator is oriented towards people’s behaviour or not. For example, an indicator measuring the amount of litter in the streets may depend both on people’s willingness to throw litter in dustbins and on the effectiveness of city management.

To this may be added that Barcelona stated reasons such as ‘improving communication strategies in alliance with the media’ and ‘lending credibility’, which are additionally suggestive of an interest in using the indicators to communicate with the media and actors outside the city, such as other city administrations or potential future residents. This is probably true for most cities, if not all, but it was clearly expressed only in documents drawn up by the city of Barcelona. It should be emphasised that this external use of indicators must be linked to an awareness of possible risks to credibility. Sustainability represents an important trend, and it carries a positive and responsible image. Many city councils (like many companies) therefore want to project a sustainability-friendly image, regardless of the actual impact that their activities may have on the environment. However, if the story told is too far removed from the reality of the existing practices or state, it becomes ‘greenwashing’ (Devauld and Green 2010). In fact, it is very easy to interpret statistics, trends and numbers in general in a way that makes an administration look good, and it is even easier to design indicators for this very purpose. This risk will probably increase as cities and regions compete to attract new residents, businesses, investors and tourists, and it should be kept in mind that city administrations also have to satisfy existing taxpayers and voters. In this context, sustainability is a vital concept in territorial marketing and city branding.

Indicator sets
The cities use between 21 and 82 indicators to measure sustainability; see Table 1. The analysis shows that half of the cities have an equal distribution of their indicators between social and environmental issues. By contrast, economic issues were found to be strongly under-represented.

On average, each city has about 20 indicators to measure social and environmental issues, respectively. The cities that lack this balance are Hanover and Riga, which strongly emphasise environmental issues, and Birmingham and Linköping, which by contrast emphasise social issues. However, it must be added that a comparison of this type is difficult to make since each set of indicators has been developed within a specific context. For example, Hanover explicitly declared that it had restricted its indicators to environment-related sustainability. Not surprisingly, social themes or sub-categories covered by indicators commonly include security, education, health, governance and socio-economic concerns such as housing, income and employment. The environmental indicators represent issues such as water, air and landscape as well as transport and waste.

While there generally seems to be a balance between social and environmental issues at the overall level, it is clear that there is a lack of balance between sub-categories. For example, environmental engagement is rarely used compared with social economics or health, and within the environmental field, indicators oriented towards water and air are more often used than those oriented towards waste and biodiversity.

In total, 332 indicators were used by the eight cities, representing 276 different ones (see Table 2). Of about 153 indicators related to social phenomena and 166 to environmental phenomena, only 7 and 24 indicators, respectively, were used by more than one city. In other words, only 5% of the social indicators, 0% of the economic indicators and 20% of the environmental indicators were used by more than one city.

Table 1. Number of inhabitants in the eight cities, total number of indicators used by each city, and their distribution among the principal categories (Social, Economy and Environment) and their sub-categories.

		Ancona [%]	Barcelona [%]	Birmingham [%]	Coventry [%]	Hanover [%]	Helsinki [%]	Linköping [%]	Riga [%]
SOCIAL	Security	3	0	19	5	0	2	2	7
	Education	3	8	8	10	0	6	10	2
	Health	7	4	17	5	0	4	8	6
	Social and community services	10	4	8	0	0	2	2	0
	Litter	0	0	14	5	0	0	0	0
	Environmental engagement	0	8	0	0	3	1	2	0
	Demography	3	0	3	0	0	6	10	4
	Governance	7	8	8	10	0	2	14	9
	Social economics	0	12	14	24	0	24	14	7
		35%	43%	92%	57%	3%	49%	62%	35%
EC	Business	10	0	0	0	0	1	8	2
		10%	0%	0%	0%	0%	1%	8%	2%
ENVIRONMENT	Economics	0	4	0	0	0	1	2	0
	Transport	3	12	0	5	18	9	4	15
	Energy	0	4	0	5	18	5	6	2
	Biodiversity	7	4	0	0	0	6	0	0
	Waste	7	12	6	10	9	5	2	11
	Landscape	17	4	0	10	18	5	6	4
	Air	7	8	3	5	15	11	8	13
	Water	14	12	0	10	21	9	2	19
		55%	57%	8%	43%	97%	50%	30%	63%
	No. of inhabitants (in thousands)	100	1600	1000	300	500	600	100	700
	Total number of indicators	29	26	36	21	34	82	50	54

Table 2. Number of sustainability indicators used in the categories of Social, Economy and Environment

	SUB-CATEGORIES	Number of indicators used across all 8 cities	Number of different indicators	Number of indicators used				
				Twice	Three times	Four times	Five times	Six times
SOCIAL	Security	16	15	1				
	Education	19	19					
	Health	20	19	1				
	Social and community services	10	10					
	Litter	6	6					
	Environmental engagement	5	5					
	Demography	14	12		1			
	Governance	23	20			1		
	Social economics	44	40	2	1			
		157	**146**	**4**	**2**	**1**		
EC.	Business	9	9					
		9	**9**					
ENVIRONMENT	Economics	3	3					
	Transport	28	26		1			
	Energy	16	14	2				
	Biodiversity	8	6		1			
	Waste	23	10	2	1		1	1
	Landscape	23	18	2		1		
	Air	31	17	2	3	2		
	Water	34	27	3	2			
		166	**121**	**11**	**8**	**3**	**1**	**1**
	TOTAL:	**332**	**276**	**15**	**10**	**4**	**1**	**1**

These findings do not fit well with the idea, presented in certain contemporary approaches to indicator design, according to which it ought to be possible to compare indicator sets. Possible explanations for the variation found are that those in charge of developing the indicators are: (a) forced to use the available data, which is a consequence of using a data-driven approach; (b) predisposed towards their own scientific backgrounds, meaning that, say, a lack of economists could reduce the number of economic indicators; and (c) influenced by specific local situations and problems, meaning that a city seeking to address social problems may emphasise social aspects over environmental ones. However, the existence of such a broad variety of designs may also indicate that the wheel is sometimes being reinvented. There also seems to be little willingness to develop common indicators, which would provide a basis for comparison among cities. This aspect is also highlighted in an EEA report:

> Quality of life in cities relies on a range of components such as social equity, income and welfare, housing, a healthy environment, social relations and education. The environmental elements of good quality of life include good air quality, low noise levels, clean and sufficient water, good urban design with sufficient and high quality public and green spaces, and a good local climate or opportunities to adapt to climate change. However, urban-specific data are patchy in Europe and, due to different timescales and reporting methods, are seldom directly comparable. (EEA 2010, p. 4)

PSR model

In this study, the categorisation of indicators as pertaining to either pressure, state or response was done on the following basis: An indicator was deemed to relate to *response* if it included political decisions and people's behaviour: that is, what people *do*. This may be represented by the fraction of waste that is recycled or by the number of tree adoptions. Indicators relating to *state* include certain rather obvious cases, for example the local population of a bird species, the number of homeless people or the concentrations of certain types of particles in air and water. However, this category was also deemed to include indicators measuring people's opinions and emotions: what people *think and feel*. Examples of this type include local residents' satisfaction with parks and open spaces or their perceptions of the city. Finally, the category of *pressure* is less obvious. Possible environmental examples include emissions of pollutants in kilograms or tonnes per capita, and for economic or social phenomena one example is the number of cars per 1,000 people. Our analysis of indicators using the PSR model as described above showed that 67% of the indicators measured state while 26% measured response and 6% measured pressure.

An additional aspect: the global context

One feature common to all of the sets of indicators investigated is a lack of information about how the cities affect areas outside their local region. It is well established that trade, travel, energy supply, etc., have a huge impact on sustainability today. This is admittedly a highly complex issue, but it would be interesting to try to expand the indicator sets in order to supply at least some information about this wider or global impact. The theoretical traditions that would be most relevant for the analysis of linkages between urban processes and global relations span both the social and the natural sciences: commodity chains, ecological footprints and life-cycle analysis (LCA). The connection between the latter two traditions and sustainability issues is obvious – as is the fact that neither of them offers any tools to analyse the social, political and cultural aspects of trade, travel, transport and other relevant global flows. It would therefore be beneficial for this purpose to draw upon the extensive theoretical work carried out around the concept of commodity chains. The question of how to theorise and operationalise commodity chains for analytical purposes has been of great concern among scholars in the field (Bair 2009; Hughes and Reimer 2004). To make the notion of commodity chains more applicable to the demands of sustainable development, it appears necessary to broaden the concept somewhat. This is because, while fairness and social relations have been explored to some extent in the commodity-chain literature, environmental aspects have hardly been touched upon. The task at hand, therefore, is to merge this theoretical tradition with the various theories and methods developed to analyse ecological and health-related issues along the chains, such as life-cycle analysis and ecological footprints. It will be necessary to explore this broader array of theories and methods in order to determine their usefulness in analysing commodity chains from the perspective of sustainable development. Of specific concern will be their potential for linking the relevant social, economic and ecological dimensions of resource flows.

Conclusions

Several conclusions can be drawn from this explorative study of sustainability indicators. First, the reasons given for the development of specific indicators derived from a wish to measure, analyse and evaluate sustainable development, i.e. reasons relating to internal use, and/or from a wish to inform, raise awareness and encourage action among citizens, i.e. reasons relating to external use. All eight cities studied gave reasons belonging to the first category but only three of them also mentioned reasons fitting into the second category. Second, most of the sustainability indicators studied were oriented towards social and environmental issues while fewer of them were oriented towards economic issues. Each city listed between 21 and 82 indicators. There was a general balance between social and environmental issues overall, but not between different sub-categories. For example, indicators relating to water, air or socio-economic issues were more frequently used than indicators relating to biodiversity or litter. Third, of about 153 indicators related to social phenomena and 166 related to environmental ones, only 7 and 24 indicators, respectively, were used more than once. This means that only 5% of the social indicators, 0% of the economic indicators and 20% of the environmental indicators were used by more than one city, which is a major problem if cities are to be compared. Fourth, the PSR analysis showed that 67% of the indicators measure state, 26% measure response and 6% measure pressure.

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Appendix 1. Found indicators

	City
A	Ancona, Italy
B	Barcelona, Spain
Bi	Birmingham, United Kingdom
C	Coventry, United Kingdom
H	Hannover, Germany
He	Helsinki, Finland
L	Linköping, Sweden
R	Riga, Estonia

Indicator		Category in document	Unit
A	1	Water	Surface water quality
A	2	Water	Marine water quality
A	3	Water	Consumption (l/pc/day)
A	4	Water	Water management (% of treated water)
A	5	Biodiversity	Number of spieces (birds) in my garden
A	6	Biodiversity	Number of spieces (birds) in the region
A	7	Climate change and air quality	CO2 emissions b sector
A	8	Climate change and air quality	24 hours average of concentrations of PM10
A	9	Land use patterns	% of urbanized areas
A	10	Land use patterns	% of derelict land
A	11	Land use patterns	% of contaminated land
A	12	Land use patterns	% of natural conservation areas
A	13	Land use patterns	% of cultural conservation areas
A	14	Local mobility systems	Daily numbers of trips per citizen by mode
A	15	Waste management	Kg/pc/day of municipal wastes by type of disposal
A	16	Waste management	% of recycled wastes

A	17	Availability of local public spaces and services	People living within a 300 m distance from the area
A	18	Population, education, safety	Density of population
A	19	Population, education, safety	Average of members for each family
A	20	Population, education, safety	Achievement at secondary school
A	21	Population, education, safety	Average life expectancy
A	22	Population, education, safety	Total reported crimes
A	23	Contacts and relationships	Places for social, cultural, leisure activities
A	24	Contacts and relationships	How often people attend social and cultural events
A	25	Contacts and relationships	Quality of the internet connection of the public administration
A	26	Contacts and relationships	% of people who has access to internet
A	27	Employment and enterprises	% of employed people by sectors and gender
A	28	Employment and enterprises	Number of enterprises (large, SME and crafts) by sectors
A	29	Employment and enterprises	Number of tourists by year

B	1	Protection of green places and biodiversity and increasing urban green space	Green area per inhabitant
B	2	Protection of green spaces and biodiversity and increasing urban green space	Birds Biodiversity
B	3	Defense of a compact and diverse city, with a quality public space	Availability to public spaces and basic services
B	4	Defense of a compact and diverse city, with a quality public space	Index of urban renovation
B	5	Improve mobility and make pedestrian life a welcome setting	Modes of transport of the population
B	6	Improve mobility and make pedestrian life a welcome setting	Proportion of roads with priority of pedestrians
B	7	Obtain optimal levels of environmental quality and create a healthy city	Level of noise pollution
B	8	Obtain optimal levels of environmental quality and	Environmental quality of the beaches

		create a healthy city	
B	9	Obtain optimal levels of environmental quality and create a healthy city	Quality of the air
B	10	Obtain optimal levels of environmental quality and create a healthy city	Birth life expectancy
B	11	Conserve natural resources and promote the use of renewable ones	Total water consumption per inhabitant
B	12	Conserve natural resources and promote the use of renewable ones	Public consumption of groundwater
B	13	Conserve natural resources and promote the use of renewable ones	Energy consumption from renewable sources
B	14	Reduce waste production and strengthen the culture of reusing and recycling	Generation of urban solid waste
B	15	Reduce waste production and strengthen the culture of reusing and recycling	Collection of organic material
B	16	Reduce waste production and strengthen the culture of reusing and recycling	Selective waste collection
B	17	Increase social cohesion, enforce mechanisms for equity and participation	Academic failure
B	18	Increase social cohesion, enforce mechanisms for equity and participation	Population finishing university studies
B	19	Increase social cohesion, enforce mechanisms for equity and participation	Accessibility to housing
B	20	Increase social cohesion, enforce mechanisms for equity and participation	Degree of association
B	21	Increase social cohesion, enforce mechanisms for equity and participation	Participation in municipal affairs
B	22	Foster economic activity oriented towards sustainable development	Number of organizations with environmental certification
B	23	Progress in a culture of sustainability trough environmental education and communication	Number of schools that participate in environmental education projects
B	24	Reduce the city’s impact on the planet and promote international cooperation	Annual CO^2 emissions
B	25	Reduce the city’s impact on the planet and promote international cooperation	Number of points of sale or consumption of fair trade products

B	26	Indicator related to all the objectives of aforementioned commitment to sustainability	Degree of citizen satisfaction

Bi	1	Economy	Co2 tonnes/person
Bi	2	Economy	Recycled household waste (%)
Bi	3	Economy	Volume of residual household waste (kg)
Bi	4	Economy	Level 4+ skills in working age population (%)
Bi	5	Economy	16-24-years-old (%)
Bi	6	Economy	GVA/person (£)
Bi	7	Economy	Employment (%)
Bi	8	Economy	Reducing wordlessness in worst-performing neighbourhoods (%)
Bi	9	Economy	Increasing attainment at level 4 or above in both English and Maths at Key stage (2%)
Bi	10	Economy	Working age population qualified to at least level 4 or higher (%)
Bi	11	Stay safe in a green, clean city	Felling safe during day (%)
Bi	12	Stay safe in a green, clean city	Feeling safe outside after dark (%)
Bi	13	Stay safe in a green, clean city	Crimes per 1000 residents
Bi	14	Stay safe in a green, clean city	Public satisfaction with cleanliness (%)
Bi	15	Stay safe in a green, clean city	Land with unacceptable litter/detritus
Bi	16	Stay safe in a green, clean city	Serious violent crime
Bi	17	Stay safe in a green, clean city	Serious acquisitive crime
Bi	18	Stay safe in a green, clean city	Gun crime rate
Bi	19	Stay safe in a green, clean city	Arson fires
Bi	20	Stay safe in a green, clean city	Graffiti (%)
Bi	21	Stay safe in a green, clean city	Litter (%)
Bi	22	Stay safe in a green, clean city	Detrius (%) Fly posting (%)
Bi	23	Be healthy	Taking moderate exercises at least three times a week Adults (%)

Bi	24	Be healthy	Taking moderate exercises at least three times a week Children (%)
Bi	25	Be healthy	Male life expectancy in ‘worst’wards (years)
Bi	26	Be healthy	Female life expectancy in ‘worst’wards (years)
Bi	27	Be healthy	Low teenage pregnancy rates Rate per 1,000 15-17-year- old girls
Bi	28	Be healthy	Adult care packages being made available, when required, within four weeks of assessment (%)
Bi	29	Enjoy a high quality of life	Decent standards, with efficient heating systems and insulation Social housing (%)
Bi	30	Enjoy a high quality of life	Decent standards, with efficient heating systems and insulation Private housing (%)
Bi	31	Enjoy a high quality of life	Resident satisfaction with parks and open spaces
Bi	32	Enjoy a high quality of life	Resident satisfaction with libraries (%)
Bi	33	Enjoy a high quality of life	Resident satisfaction with museums (%)
Bi	34	Making a contribution	Residents who feel that that people from different communities can get on well together in line with the best UK cities (%)
Bi	35	Making a contribution	Residents who feel that they can influence local decision-making in line with the best UK cities (%)
Bi	36	Making a contribution	Residents who are digitally excluded (%)

C	1		Household Waste
C	2		Household Waste Recycled
C	3		Amount of Litter on our Streets
C	4		Electricity Consumption
C	5		Domestic Water Consumption
C	6		River Water Quality

C	7		Wildlife Habitats
C	8		Air Quality
C	9		Age of Death Differences
C	10		Voting in Local Elections
C	11		Passport to Leisure & Learning
C	12		Access to Information
C	13		Adult Literacy & Numeracy Skills
C	14		School Leaver Destinations
C	15		Transport to the City Centre
C	16		Unemployment Claimants
C	17		Council Tax Benefit Claimants
C	18		Homelessness
C	19		People who Live & Work in Coventry
C	20		Perceptions of the City
C	21		Perceptions of Crime

H	1	Energy and climate protection	End energy consumption
H	2	Energy and climate protection	Greenhouse gas emissions
H	3	Energy and climate protection	Use of renewable energy sources
H	4	Energy and climate protection	Use of combined heat and power
H	5	Energy and climate protection	Domestic electricity consumption
H	6	Energy and climate protection	Thermal energy consumption by the city administration
H	7	Energy and climate protection	Electricity consumption by the city administration
H	8	Mobility and traffic	Car ownership
H	9	Mobility and traffic	Car sharing
H	10	Mobility and traffic	Public transport provision

H	11	Mobility and traffic	Public transport demand
H	12	Mobility and traffic	Access to public transport
H	13	Mobility and traffic	Cycleway network
H	14	Air	Sulphur dioxide (SO2)
H	15	Air	Nitrogen dioxide (NO2)
H	16	Air	Particulates (PM10)
H	17	Air	Benzene
H	18	Soil- and land take	Brownfield site reutilisation
H	19	Recreational space, nature conservation, agriculture and forestry	Green and open spaces
H	20	Recreational space, nature conservation, agriculture and forestry	Extensive agriculture
H	21	Recreational space, nature conservation, agriculture and forestry	Organic farmland
H	22	Recreational space, nature conservation, agriculture and forestry	Protected countryside
H	23	Recreational space, nature conservation, agriculture and forestry	Tree adoptions
H	24	Recreational space, nature conservation, agriculture and forestry	Roadside trees
H	25	Water, groundwater, lakes and watercourses, wastewater	Drinking water consumption
H	26	Water, groundwater, lakes and watercourses, wastewater	Drinking water consumption by the city administration
H	27	Water, groundwater, lakes and watercourses, wastewater	Biological quality of watercourses
H	28	Water, groundwater, lakes and watercourses, wastewater	Water quality category of the River Leine
H	29	Water, groundwater, lakes and watercourses, wastewater	Wastewater purification
H	30	Water, groundwater, lakes and watercourses, wastewater	Contaminant load of sewage sludge
H	31	Water, groundwater, lakes and watercourses, wastewater	Structural quality of watercourses
H	32	Waste	Amount of waste produced
H	33	Waste	Recyclables collected
H	34	Waste	Waste disposal

He	1	Global Sustainability	Total emission of carbon dioxide
He	2	Global Sustainability	Carbon dioxide emissions per capita
He	3	Air quality	Days below average of poor air quality
He	4a 4b	Air quality	Concentration of inhalable particles and nitrogen dioxide
He	5	Air quality	Sulphur concentration of Scots Pine needles
He	6	Air quality	Led concentrations of mosses
He	7	Air quality	Scots Pine surface Lichens
He	8	Air quality	Average needles losses of conifers
He	9	marine	BHK-loads into the seas
He	10	marine	Phosphorous discharges into the sea
He	11	marine	Nitrogen discharges into the sea
He	12	marine	Water a-chlorophyll levels
He	13	marine	Sea water quality
He	14	Water	Total water consumption
He	15	Water	Specific water consumption
He	16	Energy	Total energy consumption
He	17	Energy	Energy consumption per citizen
He	18	Energy	Electricity use
He	19	Energy	Specific heat consumption
He	20	Waste	Amounts of waste deposited at refuse tips
He	21	*Removed indicator*	*Removed indicator*
He	22	Waste	Domestic waste per capita
He	23	Waste	Sorted organic waste
He	24	Traffic	Traffic levels
He	25	Traffic	Use of different traffic methods

He	26	Traffic	The number of cyclists
He	27	Traffic	The density of private automobiles
He	28	Land use distribution	Population density
He	29	Land use distribution	Green areas per inhabitant
He	30	Land use distribution	Transport infrastructure's share of the land area
He	31	Land use distribution	Land use distribution
He	32	Biodiversity	Plants species associated with herb-rich and spruce forests
He	33	Biodiversity	Bird species
He	34	Biodiversity	The surface area of protected areas and habitat types
He	35	Biodiversity	Mercury levels in Baltic Herring
He	36	Biodiversity	PCB levels in Baltic Herring
He	37	Biodiversity	Concentration of harmful substance
He	38	Demography (Socio-Economic)	Population changes
He	39	Demography (Socio-Economic)	Population by age groups
He	40	Demography (Socio-Economic)	Households
He	41	Demography (Socio-Economic)	Share of single parents families
He	42	Demography (Socio-Economic)	Economic dependency ratio
He	43	Education (Socio-Economic)	Level of education of the 25-64-year-old population
He	44	Education (Socio-Economic)	Level of education of women and men
He	45	Education (Socio-Economic)	Gender differences in the level of education
He	46	Education (Socio-Economic)	Level of education by district
He	47	Economic activity (Socio-Economic)	Job by industry
He	48	Economic activity (Socio-Economic)	Job self-sufficiency rate
He	49	Economic activity (Socio-Economic)	Income per income earner
He	50	Economic activity (Socio-Economic)	Women's income relative to men's income
He	51	Economic activity (Socio-Economic)	Employees in the information branches and other sector

He	52	Children and the youth (Socio-Economic)	Unemployment rate
He	53	Children and the youth (Socio-Economic)	Number of the unemployed
He	54	Children and the youth (Socio-Economic)	Number of the unemployed and vacancies
He	55	Children and the youth (Socio-Economic)	Recipients of living allowance
He	56	Children and the youth (Socio-Economic)	Offences involving narcotics
He	57	Health (Socio-Economic)	Life expectancy
He	58	Health (Socio-Economic)	Mortality and the most common causes of deaths
He	59	Housing conditions (Socio-Economic)	Living space in m^3
He	60	Housing conditions (Socio-Economic)	Share of households with cramped living conditions
He	61	Housing conditions (Socio-Economic)	Housing stock by tenure status
He	62	Housing conditions (Socio-Economic)	Applicant and recipients of municipal housing
He	63	Housing conditions (Socio-Economic)	Prices and rents
He	64	Housing conditions (Socio-Economic)	Household receiving housing allowance
He	65	Housing conditions (Socio-Economic)	Share of housing allowance of the total housing costs of the recipients
He	66	Housing conditions (Socio-Economic)	Number of single homeless people
He	67	Neighbourhood comfort and safety	Share of people living in noisy areas
He	68	Neighbourhood comfort and safety	Traffic accidents among cyclists and pedestrians
He	69	Neighbourhood comfort and safety	Crime against life and health per 1,000 residents

He	70	Neighbourhood comfort and safety	Joint index of basic services
He	71	Neighbourhood comfort and safety	Crimes against property per 1,000 residents
He	72	Neighbourhood comfort and safety	Helsinki tax revenues
He	73	Neighbourhood comfort and safety	Opinions of the management of municipal services
He	74	Neighbourhood comfort and safety	The status of municipal service
He	75	Neighbourhood comfort and safety	The share of children in municipal or private day-care
He	76	Neighbourhood comfort and safety	Visits to and loans from libraries
He	77	Participation and Responsibility	Opinions on environmental protection
He	78	Participation and Responsibility	Levels of glass waste sorting
He	79	Participation and Responsibility	Voter turnout in municipal elections
He	80	Participation and Responsibility	Certificates of standardized environmental management systems in enterprises
He	81	Participation and Responsibility	Area of allotments, allotment gardens and cultivated land owned by the city of Helsinki
He	82	Participation and Responsibility	Number of enterprises providing repair and maintenance service

L	1	Demokratiskt hållbar utveckling	Andel av de röstberättigade som deltagit i kommunvalet i olika delar av kommunen med specifikation för första- och andragångsväljare.
L	2	Demokratiskt hållbar utveckling	Tillgång till information om kommunen och möjligheten för medborgarna att initiera ärenden
L	3	Demokratiskt hållbar utveckling	Andel elever som är godkända i nationella proven i svenska i årskurs 5 respektive 9.
L	4	Demokratiskt hållbar utveckling	Andel som är godkända i nationella språk i åk. 9
L	5	Demokratiskt hållbar utveckling	Andelen personer 15-79 år som läser någon dagstidning en genomsnittlig dag
L	6	Demokratiskt hållbar utveckling	Antalet anställda i Linköpings kommun med utländsk bakgrund
L	7	Demokratiskt hållbar utveckling	Andel elever i grundskolans årskurs 4 – 6 och 7 - 9samt i årskurs 2 och 3 i gymnasiet som tycker att de har inflytande i skolan

L	8	Demokratiskt hållbar utveckling	Andel lärare som anser att de kan påverka skolmiljön. Resultatet fördelas på var läraren har sin huvudsakliga tjänstgöring; åk 4-6 respektive 7-9.
L	9	Demokratiskt hållbar utveckling	God självkänsla hos barn och ungdom, mäts genom enkät om ungdomars livsstil där frågan om självkänsla finns med.
L	10	Demokratiskt hållbar utveckling	Antal förtroendevalda i kommunfullmäktige fördelat efter kön, ålder, utlandsfödda och bostadsområde.
L	11a 11b 11c 11d 11e	Ekonomiskt hållbar utveckling	Antal invånare, födelseöverskott, flyttningsnetto, köns och åldersfördelning
L	12	Ekonomiskt hållbar utveckling	Disponibel inkomst är vad som återstår sedan man från bruttoinkomsten dragit ifrån slutlig skatt och lagt till skattefria transfereringar
L	13	Ekonomiskt hållbar utveckling	Öppet arbetslösa
L	14	Ekonomiskt hållbar utveckling	Andel hushåll som beviljats socialbidrag någon gång under året
L	15	Ekonomiskt hållbar utveckling	Förvärvsfrekvens, är ett mått som anger andel personer med bostad i regionen (nattbefolkning) som förvärvsarbetar i en viss åldersgrupp i relation till samtliga personer i den aktuella åldergruppen
L	16	Ekonomiskt hållbar utveckling	Företagsklimat i kommunen. Linköpings kommun använder den definition som Svenskt näringsliv har: ”Summan av de attityder, regler, institutioner och kunskaper som finns i företagarens miljö”
L	17a 17b	Ekonomiskt hållbar utveckling	Kommunens markberedskap/ utbyggnadsområden för verksamheter respektive bostäder
L	18	Ekonomiskt hållbar utveckling	Befolkningens utbildningsnivå
L	19	Ekonomiskt hållbar utveckling	Arbetspendling till/från Linköpings kommun
L	20	Ekonomiskt hållbar utveckling	Resultatutveckling i Linköpings kommun
L	21	Socialt hållbar utveckling	Antal sjukpenningdagar plus dagar med förtidspension/sjukbidrag, rehabiliteringsersättning plus förebyggande sjukpenning dividerat med antal

			sjukförsäkrade och förtidspensionerade i åldern 16-64 år.
L	22	Socialt hållbar utveckling	Antalet personer som enligt sina svar i enkät om självskattad psykisk hälsa har lindriga eller uttalade psykiska besvär
L	23	Socialt hållbar utveckling	Alkoholkonsumtion per invånare
L	24	Socialt hållbar utveckling	De hemlösa är en delmängd bland de bostadslösa (definition enligt hemlöshetskommittén)
L	25	Socialt hållbar utveckling	När hushåll ofrivilligt saknar egen hyrd eller ägd bostad.
L	26	Socialt hållbar utveckling	Ekonomisk boendesegregation (inkomstgruppers fördelning på olika bostadsområden.)
L	27	Socialt hållbar utveckling	Andel elever som är behöriga att söka till nationellt program på gymnasiet
L	28	Socialt hållbar utveckling	Andel elever som fullföljer sin gymnasieutbildning inom fyra år efter påbörjad utbildning
L	29	Socialt hållbar utveckling	Antal besök på huvudbiblioteket, filialer och bokbussen.
L	30	Socialt hållbar utveckling	Polisanmälda brott
L	31	Ekologiskt hållbar utveckling	Beviljande av miljöstöd för ekologisk odling på åkermark
L	32	Ekologiskt hållbar utveckling	Välhävdad ängs- och hagmark med beviljad tilläggsersättning: areal
L	33	Ekologiskt hållbar utveckling	Bensinförsäljning per kommuninvånare
L	34	Ekologiskt hållbar utveckling	Andel skyddad natur
L	35	Ekologiskt hållbar utveckling	Elanvändning per kommuninvånare
L	36	Ekologiskt hållbar utveckling	Andel av förnybar elproduktion
L	37	Ekologiskt hållbar utveckling	Kvävedioxid i tätortsluften (µg/m3)
L	38	Ekologiskt hållbar utveckling	Bensen i luft
L	39	Ekologiskt hållbar utveckling	Svavelnedfall
L	40	Ekologiskt hållbar utveckling	Kvävenedfall

L	41	Ekologiskt hållbar utveckling	Andel KRAV-mjölk
L	42	Ekologiskt hållbar utveckling	Mängd insamlat hushållsavfall per invånare
L	43	Ekologiskt hållbar utveckling	Halten kadmium och kvicksilver i mg/kg torrsubstans avloppsslam
L	44	Ekologiskt hållbar utveckling	Andel kollektivtrafikresor per invånare
L	45	Ekologiskt hållbar utveckling	Antal företag med miljöledningssystemet ISO 14001 eller EMAS

R	1	drinking water	Households with access to water (%)
R	2	Air emission	CO_2 (tones/capita/year)
R	3	Air emission	NO_x (tones/capita/year)
R	4	Air emission	SO_2 (tones/capita/year)
R	5	Air quality	Carbon Monoxide (CO) (days/year)
R	6	Air quality	Nitrogen Dioxide (NO_2) (days/year)
R	7	Air quality	Ozone (O_3) (days/year)
R	8	Air quality	Sulphur dioxide (SO_2) (days/year)
R	9	City product	City product per capita (US dollar/capita)
R	10	Energy consumption	Electricity use /capita (GWh/ person/year)
R	11	Green areas	Percentage of built-up area (%)
R	12	Health care	City budget allocated to health care (%)
R	13	Housing price	Ratio of dwelling cost to median household income (ratio)
R	14	Infant mortality	Infant mortality, female (%)
R	15	Infant mortality	Infant mortality, male (%)
R	16	Investments in green areas	Annual investments per city product (%)
R	17	Investments to water supply systems	Investments to water supply (%)
R	18	Organizations using environmental audit systems	Percentage of organizations (%)
R	19	Participation in decision making	Percentage of decisions (%)
R	20	Participations in elections	Local elections (%)

R	21	Participations in elections	Referendums (%)
R	22	Poor households	Households below the poverty line (%)
R	23	Population density	Population density (People/km2)
R	24	Population growth	Total number (number)
R	25	Presence of LA 21 process	Number of activities(number)
R	26	Price of water	Price of water (US dollar/100 liters)
R	27	Quality of drinking water	Chemical quality (%)
R	28	Quality of drinking water	Microbiological quality (%)
R	29	Quality of drinking water	Number of days in expedience (days)
R	30	Quality of drinking water	Population affected (number of people)
R	31	Recycling	Glass (% recycled)
R	32	Recycling	Metal (% recycled)
R	33	Recycling	Paper (% recycled)
R	34	Recycling	Plastic (% recycled)
R	35	Rent-to-income ratio	Rent-to-income ratio
R	36	Safety	Drug pushing (Crimes per 1000 people)
R	37	Safety	Homicides (Crimes per 1000 people)
R	38	Safety	Rapes (Crimes per 1000 people)
R	39	Safety	Thefts (Crimes per 1000 people)
R	40	School attendance	Public school attendance (%)
R	41	Transport modes	Bicycle (%)
R	42	Transport modes	Bus or minibus (%)
R	43	Transport modes	Foot (%)
R	44	Transport modes	Motorcycle (%)
R	45	Transport modes	Other modes (%)
R	46	Transport modes	Private car (%)
R	47	Transport modes	Train or tram (%)

R	48	Travel times	Travel time (minutes)
R	49	Waste production	Total solid waste produced (tones/person/year)
R	50	Waste production	Total solid wastes produces (m3/person/year)
R	51	Wastewater treatment	Percentage of BOD removed (%)
R	52	Wastewater treatment	Percentage of dwellings serviced (%)
R	53	Wastewater treatment	Percentage of wastewater treated (%)
R	54	Water consumption	Average consumption of water (liters/day/person)

Appendix 2. Categorisation of indicators

SOCIAL		
SECURITY		16 indicators in total 15 different indicators 1 indicator used 2 times
C 21	Perception on crime	
Bi 11		
Bi 12		
Bi 13	Crime per residents	
L 30/ A 22	Total amount of crime	
Bi 18	Different types of crime	
R 36		
R 38		
R 37		
R 39		
Bi 16		
Bi 17		
Bi 19		
He 69		
He 71		

SOCIAL		
EDUCATION		19 indicators in total 19 different indicators
He 75	Pree school	
C 13	Literacy	
A 20		
Bi 10		
Bi 4		
He 43	Level of education in different aspects	
He 46		
He 45		
He 44		
L 18		
C 14		
R 40		
L 27		
L 28		
Bi 9		
L 3		
L 4		
B 17		
B 18		

SOCIAL		
HEALTH		19 indicators in total 18 different indicators 1 indicator used 2 times
A 21/ He 57	Life expectancy	
Bi 28		
L 21		
L 23		
R 12		
R 14		
R 15		
B 10		
Bi 23		
Bi 24		
Bi 25		
Bi 26		
Bi 27		
C 9		
He 58		
He 56		
A 19		
L 22		

SOCIAL		
SOCIAL AND COMMUNITY SERVICES		9 indicators in total 9 different indicators
He 76	Library	
Bi 32		
L 29		
A 17	Service, leisure	
B 4		
Bi 31		
Bi 33		
A 24		
A 23		

SOCIAL		
LITTER		6 indicators in total 6 different indicators
Bi 14	Litter	
C 3		
Bi 21		
Bi 15		
Bi 20	Graffiti and fly posting	
Bi 22		

SOCIAL		
ENVIRONMENTAL ENGAGEMENT		5 indicators in total 5 different indicators
H 23	As tree adoption; KRAV; opinions on environmental protection	
L 41		
B 25		
He 77		
B 23		

SOCIAL		
DEMOGRAPHY		14 indicators in total 12 different indicators 1 indicator used 3 times
L 11 a	Population	
L 11 b		
L 11 c		
L 11 d		
L 11 e		
He 39		
Bi 5		
He 41		
He 40		
He 38		
R 24		
He 28/A 18/R 23	Population density	

SOCIAL		
GOVERNANCE (DEMOCRACY)		23 indicators in total 20 different indicators 1 indicator used 4 times
Bi 36	Internet	
A 26		
A 25		
L 10	Different communities	
L 6		
Bi 34		
Bi 35	Influence	
L 2		
L 7		
L 5		
L 8		
C 12		
He 82		
B 20	Participations	
B 21		
R 19		
R 25		
R 18		
R 21		
L1/R20/C10/He79	Voting	

ECONOMY		
BUSINESSES		9 indicators in total 9 different indicators
R 9		
A 27		
A 28		
A 29		
L 16		
L 20		
L 17a		
L 17 b		
He 72		

SUSTAINABLE DEVELOPMENT		
SUSTAINABLE DEVELOPMENT		4 indicators in total 4 different indicators
B 26	A bit difficult to define, as like perception of the City	
C 20		
L 9		
He 74		

SOCIAL		
SOCIO-ECONOMICS		42 indicators in total 38 different indicators 2 indicator used 2 times 1 indicator used 3 times
Bi 29	Housing	
He 60		
Bi 30		
L 26		
He 59		
He 62		
He 61		
B 19		
B 3	Services	
He 73		
He 70		
He 51	Unemployment	
He 54		
He 48		
He 47		
Bi 8		
L 15		
C 19		
He 52		
Bi 7		
He53 / L13/ C16	Number of unemployment	
He 42	Allowance	
He 55		
He 65		

C 17		
L 14 / He 64	Household receiving allow.	
C 18	Homeless	
L 24		
He 66		
L 25		
R 13	Income	
He 50		
He 63		
R 35		
R 26		
R 22		
Bi 6		
L 12 / He 49	Income per earner	

ENVIRONMENT		
TRANSPORT		28 indicators in total 26 different indicators 1 indicator used 3 times
He 25		
H 10		
C15		
H 11		
H 12		
R 48		
L 19		
L 44		
A 14		
B 5		
B 6		
R 47		
H 13		
He 26		
R 41		
R 42		
H 9		
R44		
R 45		
He 24		
He 30		
R 43		
H8/He27/R46	Private car %	
He 68	Accidents	
B 7	Noise	
He 67		

ENVIRONMENT		
ENERGY		16 indicators in total 14 different indicators 2 indicator used 2 times
L 36		
L 35 / R 10	Electricity per capita	
B 13 / H 3	Energy consumption from renewable sources	
C 4		
H 5		
He 18		
L 33		
H 4		
H 6		
H 1		
H 7		
He 16		
He 17		
He 19		

ENVIRONMENT		
BIODIVERSITY		8 indicators in total 6 different indicators 1 indicator used 3 times
B 2/A 6 / He 33	Number of species/birds	
A 5		
He 32		
He 36		
He 37		
He 35		

ENVIRONMENT		
WASTE		23 indicators in total 10 different indicators 2 indicator used 2 times 1 indicator used 3 times 1 indicator used 5 times 1 indicator used 6 times
A15		
R 32		
R 34		
R 33		
R 31 / He 78	Glass (%)	
He 23 / B 15	Organic waste (%)	
B16/C2/A16 /Bi2/H33	Recycled household waste (%)	
Bi3/H34/B14/ He20/H32/C1	Household waste (ton)	
R49/He22/L42	Household waste per person (ton/year)	
R 50	Household waste per person (m3/year)	

<table>
<tr><th colspan="3">ENVIRONMENT</th></tr>
<tr><th colspan="2">LANDSCAPE</th><td rowspan="20">23 indicators in total

18 different indicators

2 indicator used 2 times
1 indicator used 4 times</td></tr>
<tr><td>A 9</td><td rowspan="10">Land use patterns</td></tr>
<tr><td>R 11</td></tr>
<tr><td>A 10</td></tr>
<tr><td>A 11</td></tr>
<tr><td>L 32</td></tr>
<tr><td>A 13</td></tr>
<tr><td>H 19</td></tr>
<tr><td>He 81</td></tr>
<tr><td>H 18</td></tr>
<tr><td>He 31</td></tr>
<tr><td>B 1/ He 29</td><td>Green areas per inhabitant</td></tr>
<tr><td>H 21 / L 31</td><td>Organic farmland</td></tr>
<tr><td>L34/C7/A12/He34</td><td>% of protected areas</td></tr>
<tr><td>H 24</td><td rowspan="6"></td></tr>
<tr><td>R 16</td></tr>
<tr><td>H 20</td></tr>
<tr><td>C 11</td></tr>
<tr><td>H 22</td></tr>
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<table>
<tr><th colspan="4">ENVIRONMENT</th></tr>
<tr><th colspan="3">AIR</th><td rowspan="22">31 indicators in total

17 different indicators

2 indicator used 2 times
3 indicator used 3 times
2 indicator used 4 times</td></tr>
<tr><td>A 8</td><td></td><td rowspan="2">PM</td></tr>
<tr><td>H 16</td><td></td></tr>
<tr><td>R 7</td><td></td><td>Ozone</td></tr>
<tr><td>He4a</td><td></td><td>Particles</td></tr>
<tr><td>L 38 / H 17</td><td>Benzene</td><td>Benzene</td></tr>
<tr><td>He4b/H15/R6/L37</td><td>Nitrogen dioxide (µg/m3)</td><td rowspan="2">Nitrogen</td></tr>
<tr><td>L 40 / R 3</td><td>NOx (tones/capita/y)</td></tr>
<tr><td>R 4</td><td rowspan="2"></td><td rowspan="3">Sulphur</td></tr>
<tr><td>He 5</td></tr>
<tr><td>L 39/R8/H14</td><td>Sulphur dioxide (days/year)</td></tr>
<tr><td>R 5</td><td>Carbon monoxide</td><td rowspan="3">Carbon</td></tr>
<tr><td>A7/B24/H2/He1</td><td>Carbon dioxide (tone/y)</td></tr>
<tr><td>R2/Bi1/He2</td><td>Carbon dioxide (tone/capita/y)</td></tr>
<tr><td>B9/C8/He3</td><td>Air quality</td><td></td></tr>
<tr><td>He 7</td><td></td><td></td></tr>
<tr><td>He 8</td><td></td><td></td></tr>
<tr><td>He 6</td><td></td><td></td></tr>
</table>

<table>
<tr><th colspan="4">ENVIRONMENT</th></tr>
<tr><th colspan="3">WATER</th><td rowspan="28">34 indicators in total

27 different indicators

3 indicator used 2 times
2 indicator used 3 times</td></tr>
<tr><td>R 51</td><td rowspan="4"></td><td rowspan="5">Wastewater</td></tr>
<tr><td>R 52</td></tr>
<tr><td>H 30</td></tr>
<tr><td>L 43</td></tr>
<tr><td>R53/A4/H29</td><td>Wastewater treated (%)</td></tr>
<tr><td>B 8</td><td rowspan="8"></td><td rowspan="10">Surface water</td></tr>
<tr><td>A 1</td></tr>
<tr><td>He 12</td></tr>
<tr><td>He 10</td></tr>
<tr><td>He 9</td></tr>
<tr><td>He 11</td></tr>
<tr><td>H 31</td></tr>
<tr><td>H 27</td></tr>
<tr><td>A 2 / He 13</td><td>Sea water quality</td></tr>
<tr><td>C 6 / H 28</td><td>River water quality</td></tr>
<tr><td>B 12</td><td rowspan="9"></td><td rowspan="12">Ground water and drinking water</td></tr>
<tr><td>H 26</td></tr>
<tr><td>He 15</td></tr>
<tr><td>R 1</td></tr>
<tr><td>R 27</td></tr>
<tr><td>R 28</td></tr>
<tr><td>R 29</td></tr>
<tr><td>R 30</td></tr>
<tr><td>R 17</td></tr>
<tr><td>B 11</td><td>Consumption (l/pc)</td></tr>
<tr><td>A 3 / R 54</td><td>Consumption (l/pc/day)</td></tr>
<tr><td>H25/He14/C5</td><td>Consumption (total)</td></tr>
</table>

<table>
<tr><th colspan="3">ENVIRONMENT</th></tr>
<tr><th colspan="2">ECONOMY</th><td rowspan="4">3 indicators in total

3 different indicators</td></tr>
<tr><td>L 45</td><td rowspan="3"></td></tr>
<tr><td>B 22</td></tr>
<tr><td>He 80</td></tr>
</table>

Biographical notes

Jesper Persson
Associate Professor in Landscape Planning and has a Doctor degree in Environmental sciences. Moved in 2002 from Chalmers University to work as a researcher at Swedish University of Agricultural Sciences and has during the last years carried out research on environmental compensation. Jesper has also work with lecturing and does coordinating a program on Build environment.

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Margaux Raimond dit Yvon
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Johan Hedren
Associate professor at Water and Environmental Studies, Linköping University engaged in research and education from a cultural and social science angle. The central themes in his research are ideologies and discourses on the environment and sustainable development, utopian thought on the same issues and the relation between politics and science.