2. Local sustainability indicators

The development and monitoring of six local indicators in Kaunas

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2.1   DEVELOPING LOCAL INDICATORS FOR SUSTAINABILITY

2.1.1   The role of indicators

Most people agree that we do not have a sustainable society. Unfortunately, we do not even have a model for one. Predicting levels of sustainability is nearly impossible. However, the establishment of sustainability indicators can serve as a basis for evaluating the direction of a community – *towards or away from sustainability.*

Setting specific targets is valuable, but working with indicators makes it easier to understand the hierarchy of needs, and to receive valuable feedback about the driving forces in the movement towards sustainability. Indicators provide meaning beyond the attributes directly associated with them. In this sense, they are different from primary data or statistics, providing a bridge between detailed data and interpreted information. The terminology adopted by the OECD countries leads to the following definitions[1]:

Indicator: A parameter, or value derived from parameters, which points to/provides information about/describes the state of a phenomenon/environment/area, with a significance extending beyond that directly associated with a parameter value.

Index: A set of aggregated or weighted parameters or indicators.

Parameter: A property that is measured or observed.

It is worth mentioning that every indicator has limitations. However, despite limitations, much can be lear-

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ned through a determined scrutiny of the data. Indicators can be used at international and national levels as well as at the sub-national, ecosystem or municipal levels.

The following principles were decided upon when creating the present indicators of sustainable development:

– Use of existing data;
– Integrate long-term focus with short term change;
– Relate indicators to the individual;
– Identify directions of sustainability;
– Present indicators as a whole system (determine linkage).

2.1.2 The UN Commission on Sustainable Development (CSD) indicators

The Commission on Sustainable Development (CSD), which grew out of the Earth Summit in Rio de Janeiro in 1992, followed up on the interest, and approved a work programme on Indicators of Sustainable Development (ISD) at its Third Session in 1995. The objective of the Work Programme was to make indicators available to decision makers at the national level by the year 2000[2].

The consensus-building approach adopted by the CSD consists of three essential elements and aims to develop a framework and a core set of indicators and related methodology sheets. First, from the very beginning, efforts were focused on the development and use of indicators at the national level. Second, there was a need to build on the existing national and international indicator work being carried out by several organizations and countries. Third, there was a high degree of cooperation and collaboration among more than 30 organizations and major group partners acting as lead agencies for particular indicators and with additional valuable input from approximately 50 experts from national governments.

This cooperative arrangement resulted in the preparation of a working list of 134 indicators of sustainable development, a framework for their organization, and methodology sheets for each of the indicators. To facilitate understanding, methodology sheets provided a definition of each indicator, its meaning and applicability. The methodology sheets were published by the United Nations in October 1996 as *Indicators of Sustainable Development: Framework and Methodologies*.

2.1.3 The Driving force-State-Response (DSR) framework

The indicators include social, economic, environmental, and institutional aspects of sustainable development and are placed within a *Driving force-State-Response* (DSR) framework. The DSR is a matrix that incorporates three types of indicators vertically and the different dimensions of sustainable development horizontally.

"Driving Force" indicators encompass human activities, processes, and patterns that impact on sustainable development. "State" indicators refer to the state of sustainable development and "Response" indicators highlight policy options and other responses to changes in the state of sustainable development.

Relevance to the DSR framework and placement of the indicators in the framework have not been used directly

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Use of indicators in Agenda 21 Kaunas

This case study presents experiences gained from the municipal project *Agenda 21 Kaunas* financed by the Phare Cross Border Co-operation Project Facility (September 1998 – August 1999).

An Environmental Quality working group representing a broad spectrum of municipal management activities consisted of experts in the fields of environmental monitoring, energy production, urban planning and health care. Improvement of urban environmental quality through identifying and remedying interrelated bottlenecks in city planning and management was set as one of the tasks for the group. It was determined that a quantitative evaluation of city development should be assessed using a set of local sustainability indicators.

As a result, six core indicators were recommended for introduction into city management, as presented below. These were:

1. Citizen satisfaction with the local community: level of citizen satisfaction in general and with regard to specific features in the municipality

2. Local air quality: Number of days with good and healthy air quality

3. Local mobility and passenger transportation: Daily passenger transportation distances and modes of transportation

4. Local contribution to global climate change: CO_2 equivalent emissions (total value and variations)

5. Availability of local public open areas and services: Citizen access to nearby green areas and basic services

6. Noise pollution: Share of the population exposed to harmful environmental noise

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as criteria in the selection of indicators. Instead, indicators have been identified for each cell using the criteria mentioned before. As a consequence, the number of indicators for each cell varies considerably from none to seven indicators. This helps ensure that only the most relevant indicators are selected and to identify areas for which suitable indicators do not yet exist, for example in relation to the cluster of institutional indicators.

The use of the DSR framework does not mean that it is possible at this stage to identify any causal relationships among driving force, state, and response indicators. Rather it should be seen a way of categorizing indicators to fit the needs of the producers and the users. Nevertheless, as time series data are collected and analysed for these indicators, patterns and relationships may emerge that highlight connections and interactions among indicators. The search for a set of indicators is a process involving trial and error. It will also eventually involve moving from linear to dynamic models of sustainable development.

KAUNAS
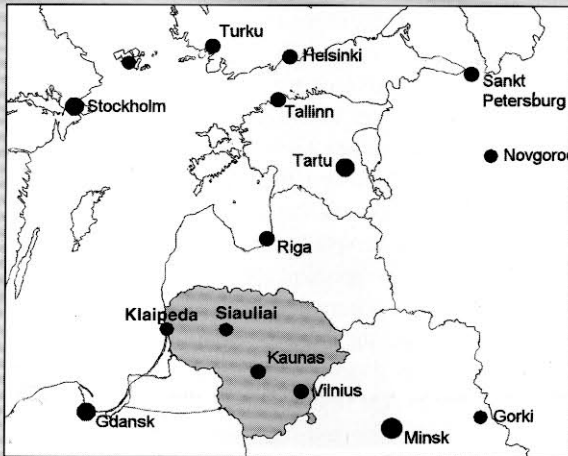
Map of Lithuania in the Baltic Sea region.
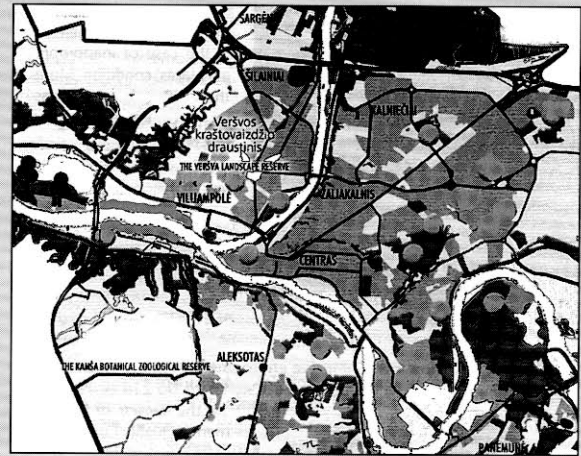

Map of Kaunas City.

Second city of Lithuania

Lithuania is a small country on the east coast of the Baltic Sea. The area of Lithuania covers 65 000 km². The population is about 3,700,000.

The capital Vilinius has 553,000 inhabitants and Kaunas, the second largest city, has 379,000. Kaunas is situated in the middle of the country, at the confluence of the two biggest rivers in Lithuania, Nemunas and Neris. Kaunas is also at the crossroad of main European transport corridor highways and railways. The biggest volumes of cargo are transported through the international airport.

History

The approximate date of foundation is the 12th century. In 1409 Kaunas became a town, receiving Magdeburg rights. The Old Town in Kaunas dates to the 15th and 16th centuries, when Kaunas was a big trade and crafts centre due to its location by important river ways.

Between 1919-1940 Kaunas was the temporary capital of Lithuania.

Education & Culture

Many educational and scientific institutions have been concentrated in Kaunas: 10 universities with 25,000 students, 13 colleges, and 18 scientific research institutions. Kaunas is also a centre of culture. It has 8 theatres, 10 museums and 33 libraries. The tourism potential is good, because of numerous historic and architectual monuments, as well as for the nature.

Urban environment

The two rivers, Neumas and Neris, divide the area of Kaunas into three parts, which are developed differently. The north-eastern part, which includes the city centre, the biggest housing estates and industrial areas, is the most developed. Less developed is the north-western part of the city, beyond the Neris river, and least developed is the southern part, with sparsely built-up districts and natural lands. Kaunas has a well developed structure of green areas. There are beautiful forest parks in the city. Other characteristic landscape elements are green slopes of valleys, forming excellent backgrounds for the urban environment in Kaunas.

Visions of the City

Kaunas – A centre of creative technologies concentration and distribution
There are good preconditions to create a space for creative technologies, due to big scientific potential of universities as well as a higly educated labour force. Kaunas has good possiblilities to implement R&D principles, cooperation between universities and industry in for example chemistry, information technology and construction.

Kaunas – An educated city
Universities have a big influence on city development, especially on the social structure. A high concentration of students and scientific institutions increase the attractiveness of the city for investors and visitors.

Kaunas – Logistics and communications centre
Kaunas having good connections to road, rail, air and water transport networks, has excellent possibilities to develop multimodal zones, where different kinds of transport could act reciprocally. There are good places to establish logistics structures, which enable big scale trasport operations.

Kaunas – A sustainable city
Kaunas being developed in a sustainbale way, must be planned as a multifunctional, compact city with well balanced zones and urban and natural space. The important conditions for sustainability is quality of the city environment, respect for natural and historic values, and the lifestyle of the city community. The first two conditions are achievable by planning measures, and the last one is a result of continuing social transformations.

Saulius Lukosius,
Municipal Enterprise Kauno Planas

2. LOCAL SUSTAINABILITY INDICATORS

2.1.4 European common indicators

The European wide sustainability monitoring initiative "Towards a Local Sustainability Profile – European Common Indicators" has been developed using a bottom-up approach by a Working Group of the Expert Group on the Urban Environment[3] in close consultation with local authorities across Europe. Extended information on the initiative is publicly accessible on the Internet[4].

The main philosophy behind this work was that a sustainable city is more than simply a city with a clean environment. Indicators for local sustainability must therefore go beyond traditional environmental indicators. They must also go beyond the s ectoral approach, where "sustainability" indicators is taken to mean indicators that are organised under the individual themes of environment, economy, and social aspects, without reflecting the linkages between the themes.

The principles and assumptions from the initiative "Towards a Local Sustainability Profile – European Common Indicators" have been used to guide the development of sustainability indicators for Agenda 21 Kaunas. The Working Group recommended that six indicators be introduced into the city's management. The objective was to measure movement towards or away from sustainability, focusing on the extent of change over time.

2.2 SIX LOCAL SUSTAINABILITY INDICATORS – BACKGROUND AND METHODOLOGY

2.2.1 Indicator 1: Citizen satisfaction with the local community

Background: An important component of a sustainable society is the general well-being of its citizens. This means being able to live in conditions that include safe and affordable housing, the availability of basic services such as school, health, culture, etc., interesting and fulfilling work, a good quality environment (both natural and built) and real opportunities to participate in local planning and decision-making processes. The opinion of citizens on these issues is an important measure of overall satisfaction with the locality, and so it is a relevant indicator of local sustainability. Obviously these aspects do not cover all the issues of well-being and satisfaction (e.g. satisfaction related to a sense of community, human relationships, personal quality of life, etc.), but it is important to consider the conditions for well-being that could be directly influenced by local, national and/or European policies.

"Citizens" refers to the people living within the administrative borders of the municipality.

"Local community" refers to the geographical area administered by the municipality. If an area considered for certain aspects (e.g. satisfaction with regard to the natural environment, employment, etc.) is confined to the immediate neighbourhood or encompasses an area larger than the municipality, this must be specified.

Methodology: Combining disparate indices into one overall index has the benefit of acknowledging links between various social parameters, but this also creates problems. How does one combine literacy rates, health care costs, and an increase in crime into one meaningful number?

Questioning citizens gives a generalised opinion about life in the municipality. A large number of negatively disposed citizens could reflect failures in local governance, inequality in employment and housing, a bad environmental situation, etc. This indicator may also assess the potential willingness of citizens to act.

There are various techniques for collecting data, varying from a low level of citizen involvement to a much higher level, which may also involve integrated methods (e.g. workshops, followed by a survey and then by a focus group on specific issues, etc.).

The size of the sample has to be determined, taking into account the need to represent the total number of people to be questioned, the internal variability of the population's characteristics, and the level of reliability of the data.

One suggestion (to be verified for correctness in the testing phase) is that in medium-sized cities, a sample of citizens could be selected representing a cross-section of the population and forming at least 0.25% of the total (considering also that this sample contains at least 1,000 individuals). If the sample is constructed with reference to families, it could be selected to represent a cross-section of families and at least 1% of the total population of the municipality, so as to obtain at least 1,000 interviews.

If the survey has collected complementary data too, it is important to produce tables and comments providing useful information for local planning or the Agenda 21 process. It is very important to explain (with tables and written comments) why people are not satisfied (specific written comments on the answers given to the open questions about the reasons for dissatisfaction with each feature) and show who is dissatisfied, with reference to age, income, and gender, if the survey is conducted with this aim (separate tables showing links between age, social-economic status, gender, and satisfaction levels).

Limitation: Combining citizen opinion from questionnaires requires complex manipulation and arbitrary parameter weighting, thus obscuring the inter-connections we wish to study. Also, such simplification is at the expense of clarity.

2.2.2 Indicator 2: Local air quality

Background: Air pollution in any significant amount can make life unpleasant or even dangerous to human health. It can increase health care costs, as it negatively affects the health of infants, older people, and persons with respiratory disease. Poor air quality can lead to restrictions for economic development, preventing permits from being issued to industries and discouraging tourism. And finally, poor air quality can increase social stress, affecting the health and quality of life for everyone.

This indicator focuses on the main sources of air pollution in urban areas, mainly linked to combustion processes in transportation, heating systems, and industries. The main pollutants emitted directly or as by-products of successive chemical reactions are sulphur dioxide, nitrogen dioxide, carbon monoxide, volatile organic compounds (benzene, for example), particulate matter, ozone, and lead. (Table 2.1)

The management of air quality involves the assessment of ambient air quality and the preparation and imple-

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Figure 2.1 Work on local sustainablility indicators proves that citizen satisfaction with the local community should be a first priority. In central Kaunas much work has been done to improve public space. Photo: Lars Rydén.

mentation of a plan or programme indicating the measures or projects that must be adopted to achieve the limit values in the areas where these are exceeded. The management plan should include measures for the main pollution sources. They may include measures directly related to mobility management (including measures regarding passenger and goods transportation, individual use of cars, public transport, introduction of alternative vehicles), heating systems (promoting, where feasible, alternative energy sources like solar or thermal energy or, where possible, use of district heating) or industrial processes.

As indicated in the EU Community Framework Directive on Ambient Air Quality (96/62/EC) the related daughter directives establish limit values intended to avoid, prevent, or reduce harmful effects on human health and the environment as a whole. The first daughter directive (1999/30/EC) defined limit values for concentration in ambient air of sulphur dioxide, nitrogen dioxide and oxides of nitrogen, particulate matter, and lead. Directive 2000/69/EC established limit values for carbon monoxide and benzene. As requested by directive 96/62/EC, limit values must also be fixed for ozone (under negotiation in the EC), poly-aromatic hydrocarbons, cadmium, arsenic, nickel, and mercury. The limit values laid down in the above directives are minimum requirements, allowing member states the possibility of introducing more stringent protective measures and stricter limit values.

In accordance with directive 96/62/EC [5] the management plans/programmes must include, among other things, the details of those measures or projects adopted with a view to reducing pollution, as follows: 1) A list and description of all the measures set out in the project; 2) A timetable for implementation; 3) An estimate of the planned improvement of air quality and of the expected time required to attain these objectives.

Methodology: The unit of measurement is the number of times the limit value is exceeded for each selected air pollutant. The number of times is calculated in accordance with the period defined by the limit value: daily (if the limit value is based on daily concentration), an eight hour

period (if it is based on an eight hours mean concentration) and hourly (if it is based on a one hour concentration). Only those fixed sampling points that respect the minimum data capture and the uncertainty of assessment methods laid down by the 96/62/EC daughter directives must be taken into consideration. If more than one fixed sampling point is available for a single pollutant in the same zone or agglomeration, the one that observes, during the year, the highest number of instances where limits have been exceeded must be used. Therefore, for each selected air pollutant, the indicator corresponds to the number of times the limit value has been exceeded *less* the number of times admitted by the 96/62/EC daughter directives in the calendar year. In case the number of times that the limit value is exceeded is lower than the number of times allowed, the indicator will be zero.

At present the indicator requires the availability of measurement data, and does not consider the possibility of making use of modelling techniques to estimate the concentration of admitted pollutants.

Limitation: Availability and accuracy of data and timely reporting determines the ability to use this indicator.

2.2.3 Indicator 3: Local mobility and passenger transportation

Background: The more we drive, the further we are from sustainability. Increased kilometres travelled reflects increased use of resources, decreased ability to work, live and participate in the neighbourhood or local community, and an increased amount of time spent on what is generally not a productive or enjoyable task – commuting from one place to another.

This indicator investigates and represents the mobility of citizens living within the local authority area. The different aspects (and the related units of measurement) that contribute to defining the general model of mobility of each citizen include:
- The number of trips that, on average, each citizen makes during the day, where 'trip' indicates a journey with a starting-point and a destination (number

Figure 2.2 Car traffic is one of the largest dilemmas of city life. Photo: Lars Ryden.

of daily trips per capita);
— The reason for the trips and their regularity during the week, allowing for the trips to be classified as either 'systematic' or 'unsystematic'[6] (% of systematic trips compared with unsystematic ones);
— The average distance covered by each citizen during the day (km/per capita);
— The time taken by each citizen for his/her trips (minutes taken for the trips);
— Modes of transport used for the trips and/or for the different distances associated with each trip (% relating to the different modes of transport considered).

Methodology: Kilometres travelled per capita is estimated using data from personal, public, and commercial modes of transportation. If such data is not available it may be preferable to multiply the size of the vehicle fleet by the estimated average fuel consumption. Fuel consumption is always available at the national level, but it is more difficult to calculate for a city, as much fuel purchased in the city

may be used for inter-city hauling. Fuel purchase within a city forms a part of the city's product, therefore evaluation of average fuel consumption could be based on revenues from motor fuel taxes.

Limitation: While the estimation of fuel consumption captures fossil fuel use by motor vehicles, it does not reflect mobility by electricity driven transport (rail or trolley), nor does it include electricity generated for transport.

It is conceptually difficult to separate motor vehicle fuel purchased for urban areas from that purchased for non-urban areas. These factors should be considered in the interpretation of the indicator.

2.2.4 Indicator 4: Local contribution to global climate change

Background: The United Nations' Framework Convention on Climate Change is the first binding international legal instrument aimed at establishing greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climatic system. According to the Kyoto Protocol, the current target for European states is to reduce CO_2 equivalent emissions to 92% of the 1990 level by the year 2012. CO_2 equivalent includes carbon dioxide CO_2, nitrous oxide N_2O, methane CH_4, sulphur hexafluoride SF_6, hydrofluorocarbons HFCs, and perfluorocarbons PFCs. These are the gases we should manage.

Many sectors are responsible for the emission of greenhouse gases. According to the methodology of the Intergovernmental Panel on Climate Change (IPCC), sectors which must be taken into account in order to arrive at a complete analysis of emissions include the energy sector, industrial processes, the use of solvents, agriculture and waste management, as well as the removal ("absorption") of carbon through forest management (also called "carbon sinks").

CO_2 emissions attributable to the energy sector (including energy production and energy consumption by

Table 2.1 Limit values of some air pollutants, according to the EU Framework Directive on Ambient Air Quality.

Pollutant	Averaging period	Air quality standards and objectives	Date by which limit value is to be attained	Data: minimum capture of measurement and uncertainty	Legal status
SO_2	24 hours	125 µg/m³ not to be exceeded more than 3 times a year *(concentration equivalent to WHO guide value)*	1 January 2005	90% 15%	Directive 1999/30/EC of April 22, 1999
NO_2	1 hour	200 µg/m³ not to be exceeded more than 18 times a calendar year *(concentration equivalent to WHO guide value)*	1 January 2010	90% 15%	Directive 1999/30/EC of April 22, 1999
PM_{10}	24 hours	50 µg/m³ not to be exceeded more than 35 times a calendar year *(concentration equivalent to WHO guide value)*	1 January 2005	90% 25%	Directive 1999/30/EC of April 22, 1999
CO	max daily 8-hour mean concentration	10 mg/m³	1 January 2005	90% 15%	Directive 2000/69/EC of November 16, 2000
Ozone[1]	daily 8-h max	120 µg/m³ not to be exceeded more than 25 days per calendar year *(concentration equivalent to WHO guide value)*	2010	90% (summer) 75% (winter) 15%	Commission proposal COM (2000) 613 of 02/10/2000

[1] For ozone, it is foreseen that there will be a target value rather than a limit value.

industry, households, transport, etc.) are by far the most important factor responsible for the greenhouse effect (industrialised countries' contribution to total emissions is about 80% of the total). The energy sector, together with the waste management sector, represent the main focus for action by the local authority.

Usually, when considering traditional contaminants affecting ambient air quality, the activities responsible for emissions in the area are inventoried and related emissions generated inside the same area are calculated. This approach has some limits when considering greenhouse gas emissions. In this case, the above mentioned inventory of activities still has to be taken, but it is good practice to calculate the related emissions, considering not only the ones that are actually generated in the area, but also those generated outside the area itself, so long as they can be traced back to the activities listed.

In other words, the geographical principle is replaced by the responsibility principle. The following are examples of this concept.

1) The city uses electricity that is produced with fossil fuel outside its boundaries: the emissions related to this production have to be accounted as due to the city itself.
2) The city makes use of natural gas that is produced elsewhere and transported up to the end users: the emissions related to the production and transportation activities have to be accounted as due to the city itself.
3) The city produces waste that is disposed of in a landfill outside its boundaries: the emissions related to such waste disposal have to be accounted as due to the city itself.

It can be useful to think of external emissions due to the import of energy vectors or to the export of waste as "debt" emissions that have to be added to local emissions. On the other hand, the city may export energy vectors to and/or import waste from other cities. Thus, emissions related to these activities should be subtracted from total domestic emissions.

Methodology: The starting point for calculating the CO_2 indicator is an analysis of energy consumption. Such data can account for emissions within the city area and due to the city's activities, as well as for "debt" emissions due to the same activities (of course "credit" emissions cannot be accounted for by means of consumption data).

Total energy consumption is the result of different activity sectors (e.g. residential, commercial, industrial, transportation, etc.). It is very useful, especially in order to give a particular direction to local actions, to analyse the contribution of CO_2 according to this sectoral disaggregation. This allows the behaviour of each sector to be clarified.

The sectorial disaggregation suggested for the CO_2 equivalent indication in the energy sector is : a) residential, b) commercial, c) industrial, and d) transportation.

The top-down approach involves disaggregating the territorial superior level of energy consumption at the local level through the use of proportionality indicators for a particular sector/activity occurring in the specified local area as follows:

$$C_{loc,I} = C_{up,I} * S_{loc,I}/S_{up,I} \quad \text{where}$$

$C_{loc,I}$ = local consumption amount related to the activity I;
$C_{up,I}$ = upper territorial level consumption amount related to the activity I;
$S_{loc,I}$ = local statistic related to the activity I;
$S_{up,I}$ = upper territorial level statistics related to the activity I.

The CO_2 emission factors (tonnes of CO_2 per unit of energy) can be derived from the IPCC Guidelines and from local and national data (especially for electricity generation).

Annual emission levels in gigagrams (Gg) of CO_2 equivalents; methane (CH_4) and nitrous oxide (N_2O) emissions are converted into CO_2 equivalents by using global warming potentials; annual percentage change in total greenhouse gases emissions beginning with 1990 as a base year would provide trends and rate of change in emission levels as required by the Climate Change Convention.

Emissions for CO_2, CH_4 and N_2O estimation is based on activity data from fuel combustion, fugitive fuel emissions, industrial processes, solvent use and other activities. Emission levels are calculated using emission factors associated with emissions of each gas for relevant activities. Information on emission data and emission factors can be found on the internet.[7]

Limitation: Total CO_2 emissions are calculated on the basis of fuel consumption, therefore the emission figures should be interpreted with caution, as information on the fuel balances, to a certain extent, are unreliable. CO_2 emissions from renewable bio-fuels are not included.

2.2.5 Indicator 5: Citizen access to nearby green areas and basic services

Background: Access to public open areas and basic services is essential in a sustainable community to the quality of life and the viability of the local economy. Having basic services close to home also reduces the need to travel. Local authorities play an important role in facilitating access to open areas and basic services through the planning process.

Access is defined as living within 300 m of an open area or other service.[8]

Public open areas are defined as:

– Public parks, gardens or open spaces, for the exclusive use of pedestrians and cyclists, except green traffic islands or dividers, graveyards (unless the local authority recognizes their recreational function or natural/ historical/cultural importance)[9]
– Open-air sports facilities, accessible to the public free of charge[10];
– Private areas (agricultural areas, private parks), accessible to the public free of charge[11].

Basic services are defined as:

– Primary public health services (general practitioner, hospitals, first-aid posts, family advice bureaux or other public centres supplying medical services, such as diagnosis or specialist examinations);

– Collective transport lines that, at least for part of a regular business day, have a minimum frequency (half-hourly service);
– Public schools (compulsory attendance schools);
– Grocery stores;
– Recycling facilities or services for solid waste (including recycling bins).

This indicator does not take the quality of the open area or service into account. In other words, it is assumed that the open areas or services perform – all in the same way – the functions for which they are intended. Naturally, this is not always the case.

Methodology: The most reliable method is based on the use of a Geographical Information System (GIS) to determine the distribution of the data (citizens, open areas, services) according to category. Once the borders of the open areas have been located on the GIS, the areas within a radius of 300 m from the borders are identified. Thus municipal land will appear to be divided into two areas: the one included in the 300 m belts around the open areas and the one not included. The GIS is consulted to obtain the number of citizens living within the areas included in the 300 m belts and the percentage of the total number of citizens is calculated. The operation is then repeated for the points (or lines or borders if appropriate) corresponding to the basic services identified.

The percentage of green areas classified according to the greenery indexes. Total area of green areas per number of inhabitants living in the city administrative territory.

The main functions of green areas in cities include:

– *Ecological compensation.* This function may help to neutralize air pollution, to improve the microclimate, to restore the biota components (biodiversity), which have an impact on biosystems;
– *Open-air recreation.* Picturesque, easily accessible, green areas are favoured and visited by citizens. Such areas, connected by pedestrian and bicycle routes, form a network of city recreational areas.
– *Urban composition.* Green areas as well as other natural elements help in the development of plans for the composition of cities, and serve to increase the expression and identity of a city. A relevant development of green networks, suitable for economic and social activities, would stimulate the expansion of business, trade, tourism, and increase investment flow.

Limitation: The network of public open areas in the city is not distributed equally, therefore citizens' access to the near-by open areas should be interpreted with some alterations.

There are open areas that are more attractive and popular than others, and the same goes for services. This weakness is, however, considered acceptable in the light of the possibility to monitor such levels of satisfaction by means of the indicator *Citizen satisfaction with the local community.*

2.2.6 Indicator 6: Noise pollution

Background: Environmental noise is the noise experienced by people outside households. Noise experienced by people in the workplace or occupational environment is not considered in this chapter.

The main source of noise in urban areas is traffic. Available data published by the OECD shows that exposure to noise, which was fairly stable at the beginning of the 1980s, in some Western European countries had increased by the end of the last decade.

The Proposal for the Community Environment Action Programme 2000-2009 includes a target on noise, i.e. by the year 2010, reducing by 10% the estimated 100 million people regularly affected by long-term high levels of noise during the year 2000 and by the year 2020 reducing the levels by 20%. The long-term objective is to reduce them to a statistically insignificant number.

Methodology: For describing the impact of noise on humans, the so-called Equivalent Sound Pressure Level (Leq) needs to be calculated, that is, the mean value of sound intensity over time expressed in decibels. However, Leq is not sufficient for the characterisation of environmental noise. It is equally important to measure and display the maximum values of noise fluctuations (Lmax), preferably combined with a measure of the number of noise events (Ln). For most people, noise pulses are more annoying than a steady pulse of noise.

In order to assess the number of citizens exposed to harmful traffic noise, outdoor measurements and dispersion modelling are required. Road traffic is responsible for the highest percentage of the European population's exposure to noise levels greater than 55dB(A) (Leq, 24-hour). In particular, the high proportions of Leq between 55 and 65 dB(A) can be attributed to the growth of traffic volume during recent years. This more than offsets any possible results of tightening noise controls as set out for example by EC legislation. In addition, tyre/road noise is now the dominant source of road-traffic noise, particularly in free-flowing traffic at speeds above 40 to 50 km/hour. Roughly speaking, each increase in vehicle numbers by 25% will result in a noise level increase of 1dB, whereby one heavy goods vehicle is equivalent to about eight passenger cars.

The draft European Directive[12] on the assessment and management of environmental noise aims to define a common approach for combating the effects of exposure to environmental noise. It lays down a framework for deter-

Table 2.2 Public opinion on different social threats.

Threat	%	Ranking
Crime	38	1
Alcoholism	30	2
Environmental pollution	9	3
Probable accident at Ignalina NPP	6	4
Drug addiction	5	5
AIDS	4	6
Cancer	3	7
Terrorism	3	8
Car accident	1	9
Others	1	10

Table 2.3 Peoples' willingness to act on behalf of natural environment.

Statement	Already doing	Ready, but not doing	Maybe	Not ready
Take care of the territory of the city	14	31	36	19
Take part in the care of one's yard	52	23	17	8
Do not use hazardous materials in the household	38	24	29	9
Make remarks to the people who are abusing nature	55	20	16	9
Discuss with local authorities about environmental problems	5	24	27	44
Send a letter concerning environmental issues to the authorities	4	18	27	51
Write to mass media about observed cases of environmental pollution	2	22	32	44
Read articles related to environmental issues	25	15	37	23

Figure 2.3 Willingness to ride a bicycle.

Figure 2.4 Reasons why Kaunas citizens do not use waste recycling containers.

mining exposure to environmental noise, making information on environmental noise and its effects available to the public, and adopting action plans. The action plans should address priorities that may be identified by the exceedance of any relevant limit value or by other criteria chosen by the Member States. The actions may for example include traffic planning, land-use planning, technical measures at noise sources, selection of quieter sources, reduction of sound transmission, and regulatory or economic measures or incentives. The objective is to prevent and reduce environmental noise where necessary, and particularly where exposure levels can induce harmful effects on human health, and to preserve environmental noise quality where it is good. The Directive is expected to enter into force at the beginning of 2002.

Limitation: Distinct variations in noise intensity and noise level can occur from place to place (even within the same general area), and from one moment to the next. Similarly there can be large variations during each day, week or year.

## 2.3 SOME RESULTS FROM ESTIMATION OF INDICATOR VALUES IN KAUNAS

2.3.1 Environmental consciousness

Let's discuss some results from the sociological survey *Environmental Consciousness,* conducted in the city of Kaunas as part of the project *Local Agenda 21 Kaunas.* The content of the survey could be characterised as community opinion on environmental issues and values clarification. The survey was conducted in the form of a questionnaire that included 1,500 Kaunas residents over 18 years of age. The main topics of the questionnaire were:

– Community opinion on the environmental situation in the city;
– Community attitudes, values, and actions compatible with sustainable development;
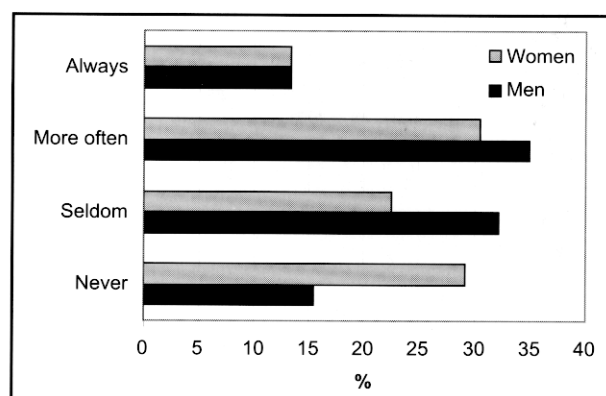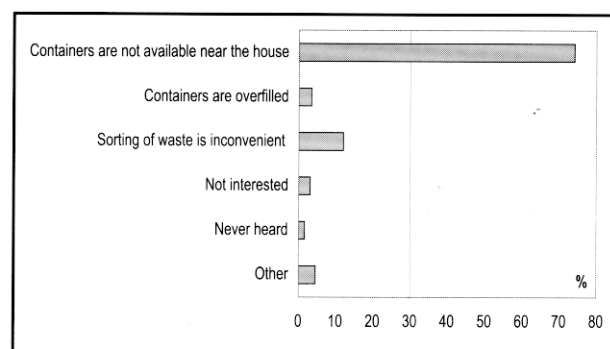
– Sources of information on sustainable development (environment);
– Role of non-governmental organisations.

One of the empirical goals of the survey was to study the relative importance that the public places on environmental pollution as compared to other social threats (Table 2.2). It is not surprising that the value difference between crime-alcoholism and perceived environmental pollution is high. When faced with basic material needs, people can not be expected to be very concerned about environmental degradation and the negative consequences to their health in the future.

It can be concluded that peoples' attitudes towards the proposals related to more locally oriented activities is generally positive. Kaunas residents are primarily prepared to participate in the improvement of their local area, make remarks to those who abuse nature, refuse to use any hazardous materials in their households. Peoples' willingness to influence authorities is comparatively low. This could be explained by the limited possibilities available for influencing either the political or economical institutions (Table 4.3).

Peoples' willingness to behave in a more sustainable way was also evaluated by respondents' attitudes towards riding a bicycle instead of driving a car, or using public transport if there were conditions appropriate for that in the city.

48% of the respondents indicated that they would like to ride a bicycle always or often, while 24% indicated that they would never choose to ride a bicycle instead of driving a car (Figure 2.3). It should be mentioned that there may be a variety of external obstacles that prevent environmentally minded individuals from behaving in an environmentally conscious way.
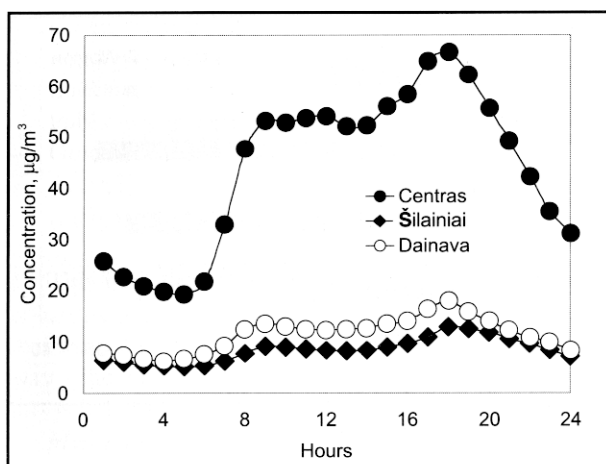
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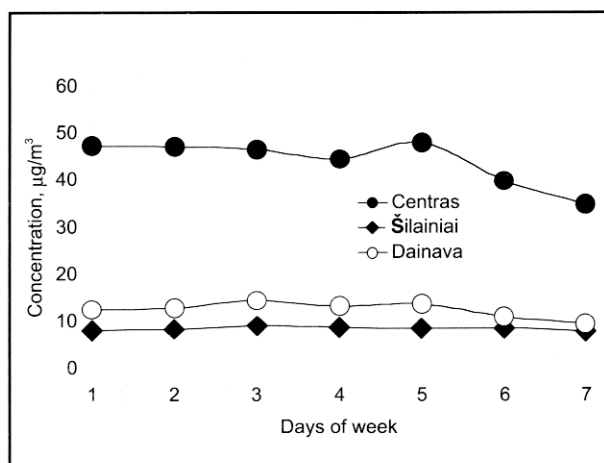**Figure 2.5** Distribution of NO_2 concentrations on a 24-h basis.

Figure 2.6 Distribution of NO_2 concentrations on a weekly basis.
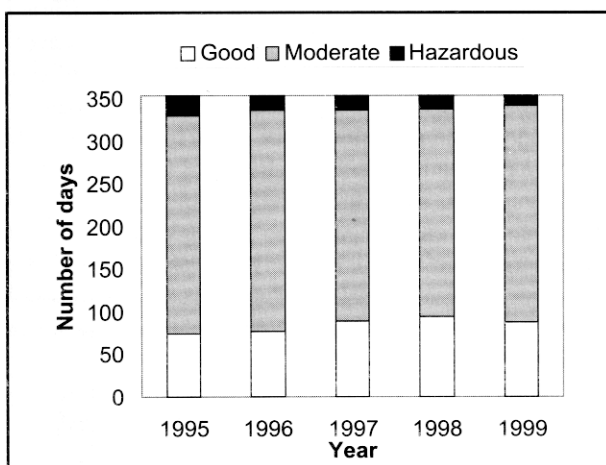

Figure 2.7 Number of days with good air quality.

The opportunity for recycling materials is mostly dependent on the development of a local infrastructure i.e. whether neighbourhood collection points are available. The responses to questions about recycling behaviour reflect not only opportunities for recycling, but also peoples' desire to do so, and their knowledge about recycling.

74% of respondents who do not use containers at all indicated that such containers are not available near their houses. 3% answered that the containers are usually overfull. These figures reflect the existence of an unfavourable infrastructure which limits environmentally responsible behaviour (Figure 2.4).

2.3.2 Local air quality

Application of similar ambient air quality indicators is exemplified by the *Kaunas Municipal Air Quality Monitoring System*. The system comprises three stationary air quality monitoring stations and mobile laboratories. Selection of the sites for the monitoring stations has been carried out according to the EU and national urban air quality monitoring requirements. The monitoring station *Centras* is situated in the downtown area of the city, the second one, *Šilainiai*, is located in a highly populated residential district and the third one, *Dainava*, is in an area where heavy industries and high traffic intensity are located. Real time data are transferred to the main computer and analysed with the AIRVIRO software. The AIRVIRO

software enables dispersion modelling and allows the possibility to develop air pollution maps.

According to EU regulations, assessment of ambient air quality is based on continuous hourly average measurements of CO, SO_2, NO, NO_2, NO_x, VOC, O_3, particulate matter concentrations, and meteorological parameters. The distribution of NO_2 concentrations during October-December in the year 2000 are presented in Figures 2.5 and 2.6.

The EU directives and national environmental legislation determine the maximum levels of key pollutants. The daily level of each pollutant is compared to a maximum threshold limit that is defined as acceptable (or "good"). If any pollutant exceeds this level, air quality for the day is characterised by the pollutant that exceeds the "good" standard to the largest degree. An increase in the number of "good" air quality days indicates improvement in air quality.

The number of "good" air quality days increased from 75 in 1995 to 95 days in 1998, at the same time as the number of "hazardous" days decreased from 25 in 1995 to 13 in 1999. This indicates that air quality is steadily improving, however data from 1999 gives rise to speculation that air quality improvement has reached a plateau, or questions as to whether the data results are due to weather pattern fluctuation. Each indicator for monitoring *quality of local outdoor air* should be monitored on a yearly basis, which gives comprehensive information for long-term urban planning.

Figure 2.8 In many cities in eastern Europe, as here in Riga, buses and microbuses provide for local mobility. Photo: Lars Rydén.

2.3.3 Local mobility

On the basis of the above mentioned assumptions and available statistical data, the mobility of Kaunas' citizens was investigated. It was found that a lack of sufficiently homogeneous and updated data is a limiting factor when evaluating local mobility and passenger transportation.

Gasoline-fuelled vehicle use creates pollution and noise as well as traffic congestion and social stress. Roads take up valuable land, thereby reducing wildlife habitats, and decreasing the amount of open space for the human community. Decreased vehicle kilometres travelled would reflect reduced travel distances, more walking and biking, and wider use of mass transport vehicles (one bus carrying 60 people instead of 60 individual cars each carrying one person).

Generally speaking, there is a lack of sufficiently homogeneous and updated data for calculation of the indicator. A simple questionnaire could be used to calculate the number of trips (by type of trip, mode of transport, time taken). The survey could be carried out by means of interviews (if necessary by telephone) on a statistically significant sample of citizens (that is, a sample of citizens selected according to criteria of representativeness). This questionnaire could be designed as in Table 2.4.

Additional occasional and heterogeneous surveys may be carried out as part of general population censuses, or as part of specific studies undertaken on the local level for the
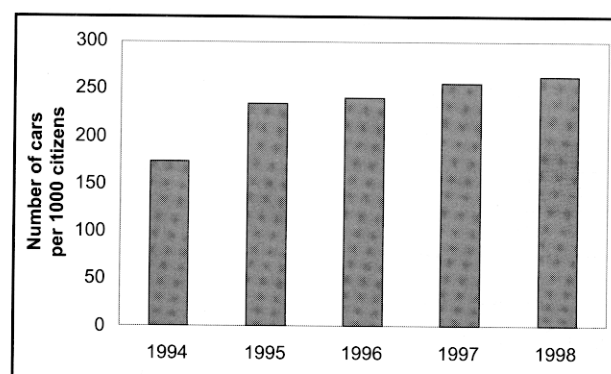
**Figure 2.9** Number of individual cars in Kaunas.
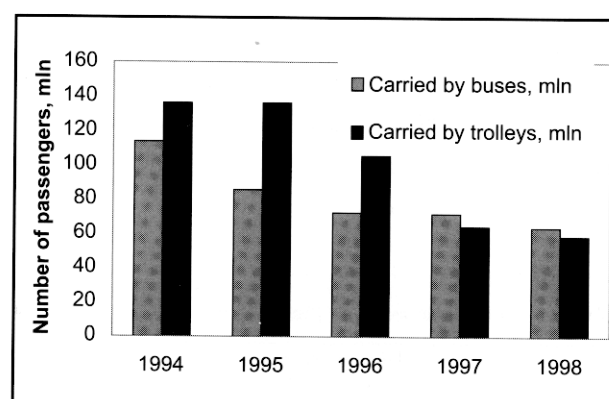
**Figure 2.10** Passengers carried by public transport in Kaunas.

Table 2.4 Urban mobility per capita.

|	Dimension	by foot	by bike	by public transport	by individual transport	by taxi	by commercial transport	All modes of communication
COMMUNICATION MODES								
Citizen mobility per capita per 24 hours	Number of trips	0.77	0.01	1.25	0.52	0.04	0.06	2.65
Citizen communication receptivity	Passenger km per 24 hours per capita	0.86	0.05	5.68	4.18	0.28	0.45	11.5
Citizen communication receptivity	Passenger hours per capita per 24 hours	0.22	0.003	0.44	0.20	0.01	0.3	1.173
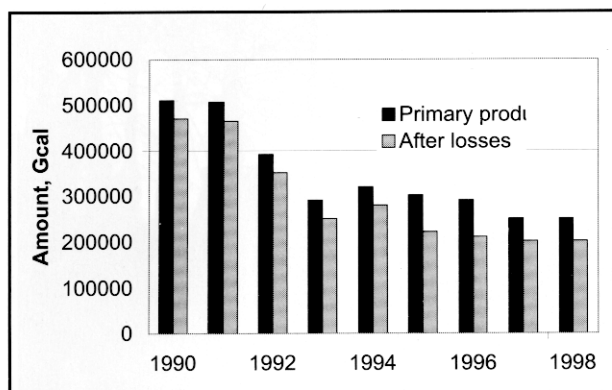
Figure 2.11 Heat production by the Kaunas thermal power plant and heat-boilers.
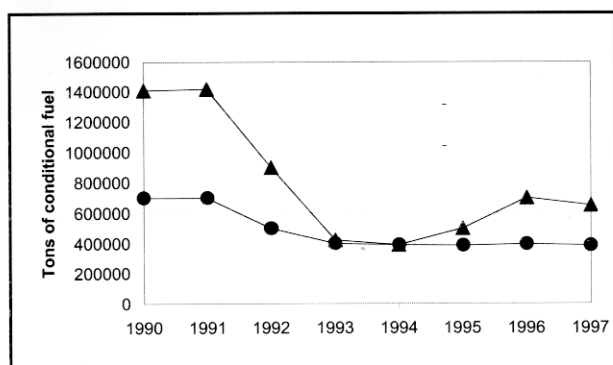
Figure 2.12 Use of heavy oil and natural gas in primary heat production.
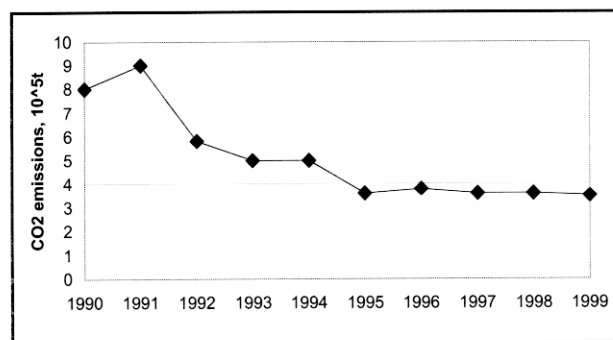
Figure 2.13 CO_2 emissions in Kaunas.

Table 2.5 Greenery indexes for the city of Kaunas.

Category of greenery	Present situation (year 2000)		Prospective situation	
	Area, ha	m²/citizen	Area, ha	m²/citizen
City parks	872	21	1074	26
Parks	290	7	574	14
Public gardens	96	2.3	67	16
Protective greenery			1244	
Connecting greenery			142	
TOTAL	**1248**	**30,4**	**3101**	**41,75**

development of sectorial plans (traffic and urban mobility plans, public transport plans, etc.). As a result, indirect methods for urban mobility estimation could be applied.

2.3.4 Local contribution to climate change

The Kaunas initiative to estimate dynamics of CO_2 emissions is described below.

The environmental quality group has concluded that current restructuring of the industrial sector in Kaunas is not settled, therefore assessment of CO_2 equivalent emissions from industries is problematic. As a result, the energy production sector, which makes a considerable contribution to the total amount of CO_2 emissions into the atmosphere, was the focal point of the assessment.

The major part of electricity used by the city of Kaunas is supplied by the Ignalina nuclear power plant, while a minor part is generated by the Kaunas hydro power station. Thus CO_2 emissions generated by the combustion of fossil fuels for heat production has been taken as the most significant pressure on the global climate. The total amount of heat produced by the Kaunas thermal power plant and the estimated amount of heat after conversion and network losses is presented in Figure 2.11. Use of fossil fuel in primary heat production is illustrated in Figure 2.12. CO_2 emissions from the Kaunas thermal power plant and boiler-houses are presented in Figure 2.13.

### 2.3.5 Citizen access to green areas and basic services

In the *Agenda 21 Kaunas* report, the working group decided to use an indicator based on the classified areas of greenery per number of inhabitants. Let's investigate the present status and prospective development of the city of Kaunas' green areas.

A systematically new approach to an optimal natural scenery in the urban environment, called *natural framework*, has been developed. It includes microstructural elements of the landscape (river valleys, groves, water-bodies, etc.) and artificially created green areas in order to compensate for the anthropogenic environmental load. A system of balanced natural urban areas is linked to the suburban green areas by linear street greenery and green areas called *green corridors*. The maintenance of these areas and their environmental composition in the most natural state possible are required, as it is only in this way that these areas will contribute to an ecological balance of the environment suitable for both human habitation and industrial activities.

Development of the Kaunas City Master Plan involves strategic planning of green areas:

– Creation of a natural city framework. The formation of street greenery will aim to connect natural and planted urban areas with suburban green areas.
– Protection and use of river valleys and slopes. The surveillance of the unique shape of the Nemunas and Neris river valleys and slopes as characteristic landscape elements of Kaunas.
– Suitable presentation of valuable natural areas. The exposure of waterfronts as important elements of Kaunas' natural structure.
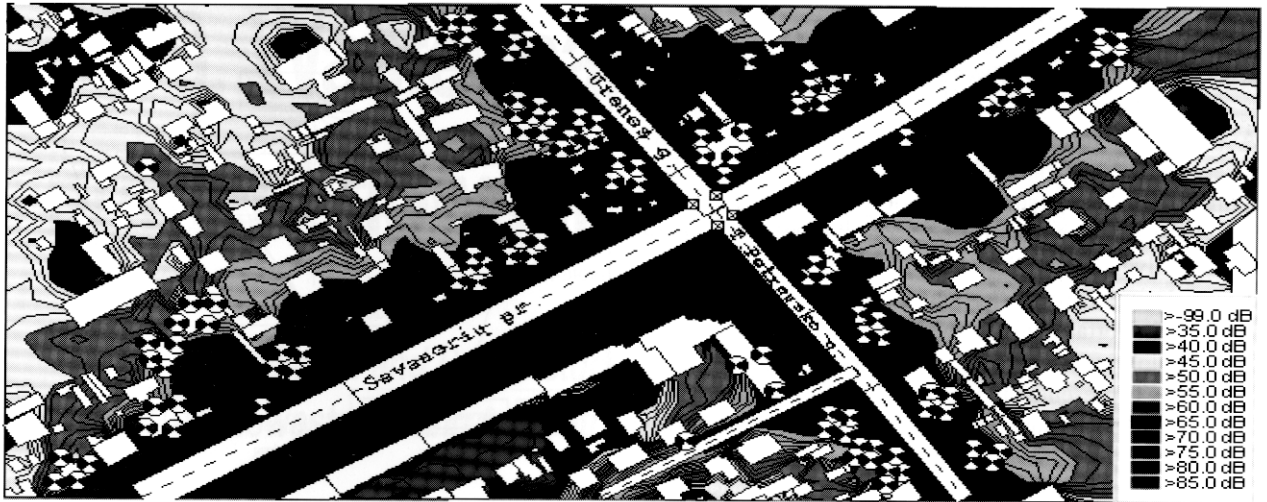
Figure 2.14 Results of day time noise dispersion modelling. The maximum noise level presence was modelled at the point closest to the road crossing. This level reaches 85 dBA, which is 20 dBA higher than maximum allowable noise levels.

– Green areas as added value to poly-functional areas. The expansion of green areas in homogeneous poly-functional spaces with residential, working and recreational facilities will reduce daily commuting.

2.3.6 Noise pollution

The traffic noise survey presented in this case study was carried out at one of the biggest city street crossings in Kaunas. The street crossing at Savanoriu Ave. and K. Petrausko-Utenos St. is in a densely populated residential area. The actual traffic flows on these streets were 1984 and 1350 cars per hour respectively.

The Computer Aided Noise Abatement programme CADNA-A (Germany) was used to evaluate noise dispersion. The calculations were based on the following parameters: traffic flows, landscape, buildings (height, number of floors), and speed limits.

Differences in traffic flows during the day and night time were calculated using equations 1-3:

$$DTV = b * Q_{15-19} \qquad (1)$$
$$D = 0.06 * DTV \qquad (2)$$
$$N = 0.011 * DTV \qquad (3)$$

where: DTV=number of cars per day; b=correction coefficient; Q_{15-19}=number of cars (15.00-19.00); D= number of cars during the day time (cars/hour); N=number of cars during the night time (cars/hour).

Nine measurement points were chosen to verify the modelling results. Points M1, M2, M3, M4, M5 were situated close to the streets, points M6, M7, M8, M9 were located inside housing blocks (Figure 2.15).

The number of people being annoyed by street noise in different districts in the city of Kaunas in 1998 was assessed. The number of people exposed to noise levels exceeding 65dB(A) were calculated (Figure 2.16).
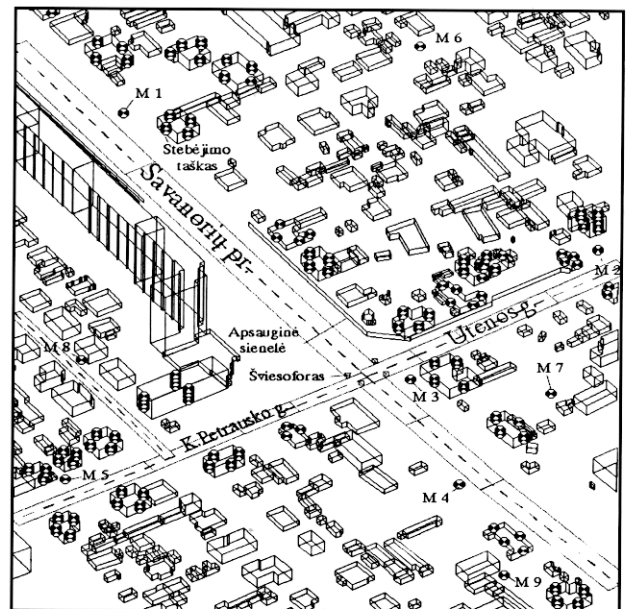
Figure 2.15 Distribution of houses and measurement points in central Kaunas.
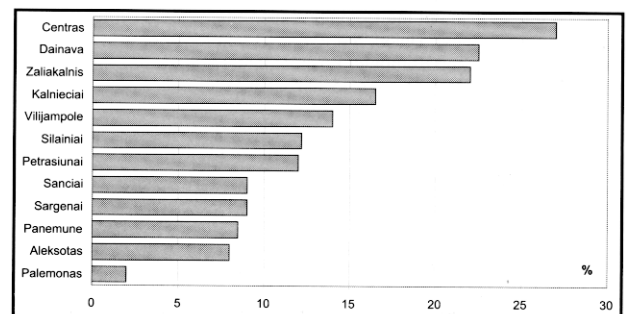
Figure 2.16 The percentage of city inhabitants exposed to 65dB(A) noise level.

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2.4   FINAL COMMENTS

2. 4.1   Structural links between local sustainability indicators

A variety of well-known indicators measure the many facets of our lives. Indicators of social character evaluate human development and quality of life. Sub-components include education, health care, cost of living, crime, cultural diversity, quality of the environment and others. These elements are most often studied in isolation, often ignoring important links between them.

A simplified web of six indicators described in this case study is presented in Figure 2.17. Most of these linkages are arrived at using logic, experience, and observation. In most cases the link is assumed to be significant.

Other connections to other indicators can easily be imagined and extrapolated. In an urban context there are close connections between mobility, carbon monoxide emissions, air quality, abundance of greenery, noise level, and citizen satisfaction.

The linkages point to possible actions and policies in the quest for sustainability. Development and introduction of sustainability indicators is a process, which necessitates participation of different stakeholders and careful examination of validity and analytical soundness. The assessment and reporting process leads to a revision of indicators and the establishment of a more comprehensive and reliable data and linkages between them. The linkages point to possible actions and policies in the quest for sustainability.
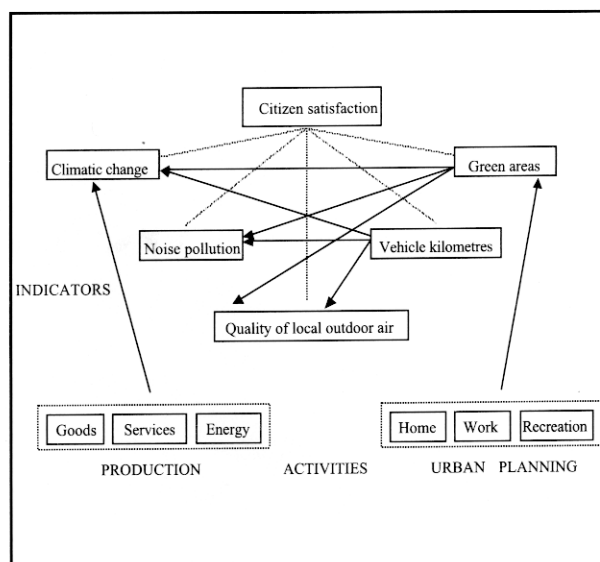
Figure 2.17 Principle links between six sustainability indicators applied to the city of Kaunas.

Notes & References

1. http://www.oecd.org
2. http://www.un.org/esa/sustdev/isd.htm
3. The Expert Group on the Urban Environment was set up by the European Commission in 1991. In 1993 the Expert group together with the European Commission launched the Sustainable Cities Project. In 1999, following the adoption of the Communication Sustainable Urban Development in the European Union, the Expert Group together with the European Commission and European Environmental Agency has initiated the development of a common set of local sustainability indicators.
4. http://sustainable-cities.org/indicators
5. *Annex IV, Information to be included in the Local, Regional or National Programmes for improvement in the Ambient Air Quality*
6. "Systematic trips" are daily journeys to work or to school. "Non systematic" or "unsystematic" are the ones made for all other reasons, i.e., to go shopping and for social or recreational reasons.
7. http://atc-ae.eionet.eu.int/etc-ae/index.htm
8. The European Environment Agency, DG Regional Policy and ISTAT (Italian Istituto Nazionale di Statistica) all use the concept 'within 15 minutes walk' to define accessibility. It may reasonably be assumed that this corresponds to around 500 m on foot for an elderly person, which in turn may be equivalent to 300 m "as the crow flies".
9. The indicator considers all areas used by the public for leisure and open-air activities. So even paved areas, if used for open air activities (i.e. skating) have to be included. On the contrary, a pedestrian road used for business and commercial activities should not be included.
10. Sport facilities should be included only if freely accessible to the public and used by common people: football fields or similar professional sport facilities should not be included.

11. Agricultural areas should be included only if used for leisure and open-air activities by the public. This is the case of farms that did "survive" urban expansion and are close to urban areas. These farms often change their commercial strategies, opening to citizens and schools, selling fruit and other products to the public and offering other services (restaurant, school visits, etc.). Agricultural areas can only be included in such cases.
12. The full text is available on the Europa web site: http://europa.eu.int/eur-lex/en/com/pdf/2000/en_500PC0468.pdf

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