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REGIONAL WASTE DATA SYSTEMS AND SUSTAINABILITY INDICATORS

REGIONALNE SYSTEMY INFORMACJI O ODPADACH I WSKAŹNIKI ZRÓWNOWAŻONEGO ROZWOJU

Abstract

The need for robust and reliable data is crucial for the creation of sustainability indicators. The regional environmental data system in Poland includes two types of databases managed by the Marshal Office (regional authority). These databases offer a vast amount of detailed information regarding the use of environment in Polish regions. There is a possibility of creating sustainability indicators on the basis of the information gathered in regional databases. The most important application of these indicators at the moment is to inform the regional policy makers and provide them with a tool to transform the environmental strategy goals into measures to accomplish and assess the progress and the legitimacy of the implemented environmental policy. Hence the support for the RAMEA project (Regionalized nAMEA-type matrix). The regional databases can be used within the framework of life cycle thinking to support the actual dealing with environmental problems instead of shifting them. The application of LCA (Life Cycle Assessment) also allows to organise the vast amount of information available into the environmental impact categories.

Keywords: sustainability indicators, life cycle assessment, waste management

Streszczenie

W celu stworzenia wskaźników zrównoważonego rozwoju konieczne są solidne i wiarygodne dane. Regionalny system informacji środowiskowej w Polsce składa się z dwóch baz danych zarządzanych przez urzędy marszałkowskie. Bazy te zawierają ogromną ilość szczegółowych informacji dotyczących wykorzystania środowiska w polskich województwach. Istnieje możliwość stworzenia wskaźników zrównoważonego rozwoju na podstawie informacji zgromadzonych w bazach danych. Najważniejszym zastosowaniem tych wskaźników jest obecnie ich rola jako syntetycznej informacji dla decydentów na szczeblu regionalnym oraz jako instrument przekształcenia celów strategii ochrony środowiska w środki ich osiągania, a także jako instrument monitorowania postępów i legitymizacji wprowadzonych programów środowiskowych. Cele te ma zrealizować macierz RAMEA (*Regionalized nAMEA-type matrix*) stworzona w ramach projektu finansowanego w programie GROW (Interreg IIIC). Regionalne bazy danych mogą być wykorzystywane wraz z podejściem „myślenia w kategoriach cyklu życia" w celu wsparcia faktycznego rozwiązywania problemów środowiskowych. Zastosowanie LCA (Ocena Cyklu Życia) pozwala także na uporządkowanie dostępnej informacji w kategorie wpływu na środowisko.

Słowa kluczowe: wskaźniki zrównoważonego rozwoju, Ocena Cyklu Życia, LCA, zarządzanie odpadami

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1. Introduction

The need for robust and reliable data is crucial for the creation of sustainability indicators (as well as any other). The regional environmental data system in Poland includes two types of databases managed by the Marshal Office (regional authority). These databases offer a vast amount of detailed information regarding the use of environment in Polish regions.

On the basis of the information gathered in regional databases there is a possibility of creating sustainability indicators regarding air emissions, water drawing, releases to the water and soil as well as wastes. The most important application of these indicators at the moment is to inform the regional policy makers and provide them with a tool to transform the environmental strategy goals into measures to accomplish and assess the progress and the legitimacy of the implemented environmental policy.

The regional databases can be used within the framework of life cycle thinking to support the actual dealing with environmental problems instead of shifting them. The application of LCA (Life Cycle Assessment) also allows to organise the vast amount of information available into the environmental impact categories. The Life Cycle approach, which requires *material* and *energy* flow (which can be expressed also in a monetary value) can be a basis for calculation on macro- and micro-level indicator for different products, branches or regions. For the creation of the final methodology, the result obtained from different techniques (LCA, MFA, IOA) should be verified and compared.

2. Characteristics of the environmental databases

The regional environmental databases include the Marshal Office database and the waste management database.

The **Marshal Office database** provides the information pertaining to the system of environmental charges in Poland (see point 3 for the explanation of the system). The database is created for the purpose of recording reports from companies about the charges (fees and fines) for using the environment – as a consequence, the database includes the volume of pollutants released to the environment. It is worth stressing that the reporting duty is compulsory for every entity that conducts the activities that lead to emissions. Since these charges are levied practically on every substance or emission released into the environment, the scope of information gathered is very wide and it includes: gases and dusts released to the air, wastewaters released to soil and water, cooling waters, waste landfilling, underground and surface water drawing, rain waters from contaminated areas.

For instance, the information pertaining to the emission to air includes the source of the emission (type, e.g. furnace, installation, source capacity, type of protection/reduction device), type of fuel/substance (eg. SO_2, NO_2, CO, CO_2, dust, etc), the emission volume, the place of emission (i.e. the commune name).

The emissions are reported on a 6-month basis and in some regions are available in the electronic format. This gives a unique opportunity to have the most up-to-date data available for further analysis. The emissions that are accounted for in the Marshal Office database include 62 substances, among others: arsenic, ammonia, asbestos, benzene, vinyl chloride, chromium, tin, zinc, sulphur dioxide, carbon dioxide, methane, nickel, lead, dusts, mercury, carbon monoxide, nitrogen oxides, metallic elements and its compounds, etc.

A separate database exists for wastes – **integrated waste information system** (ZSO – Zintegrowany System Baz Gospodarowania Odpadami) [1]. This database includes: the amount and type of produced waste and the ways of its management, the registry of the issued decisions regarding waste production and management, the waste management plans and installations that are used in order to reclaim and neutralize waste with the separation of landfills and installations for thermal transformation of waste (Tab. 1). The regional database is managed electronically and is consistent with the central database managed by the Ministry of the Environment. The information stored in the database is prepared annually by the waste producers and refers to waste production, collection, recovery and neutralization. The Ministry of the Environment operates the central database on waste production and management as well as prepares final reports for the European Commission (questionnaire connected with waste management directives and regulations) on the basis of the information collected in the database.

Table 1

Separately collected waste fractions in the Małopolska Region [t]

Waste type	Code of waste	2002	2003	2004	2005
Paper and cardboard	200101	203.9	470.4	918.24	61.7
Glass	200102	102.8	220.4	139.5	214.7
Biodegradable kitchen and canteen waste	200108	–	–	–	58.9
Clothes	200110	5.0	–	–	–
Textiles	200111	–	–	12.7	3.8
Pesticides	200119	–	13.9	–	–
Fluorescent tubes and other mercury--containing waste	200121	0.315	–	–	0.016
Discarded equipment containing chlorofluorocarbons	200123	–	–	–	0.084

Source: Marshal Office database

Apart from the official regional databases there is a growing number of **other databases** created e.g. during research projects. These databases can have a substantial role in the creation of the sustainable indicators provided they are consistent with other available data, e.g. official statistics. One of the examples of such databases is the one created during the OSELCA [2] project at the Mineral and Energy Economy Research Institute of the Polish Academy of Sciences. The OSELCA project goal was to introduce the LCA method in Estonia by carrying out a life cycle assessment of oil shale electricity. However, the project also assumed the comparison with the neighbouring countries' energy production from different sources. Since 95% of energy in Poland is based on coal, its environmental impact was also analysed. The analysis was carried out according to the rules of LCA – the data scope taken into consideration is presented in Fig. 1.

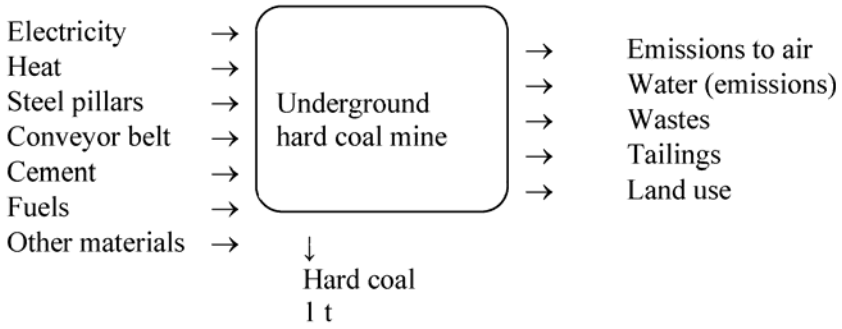

Fig. 1. LCA of the energy generation from coal in Poland (source: the OSELCA project)

Rys. 1. Analiza LCA dla produkcji energii z węgla w Polsce (źródło: projekt OSELCA)

3. Environmental charges

Environmental charges, being the origin of the Marshal Office database, are based on the assumption that every user of the environment should pay for it. One of the reasons for this is that the resources are scarce, and consequently they are less and less perceived as a free good. At the beginning of the nineties, these charges represented a substantial cost

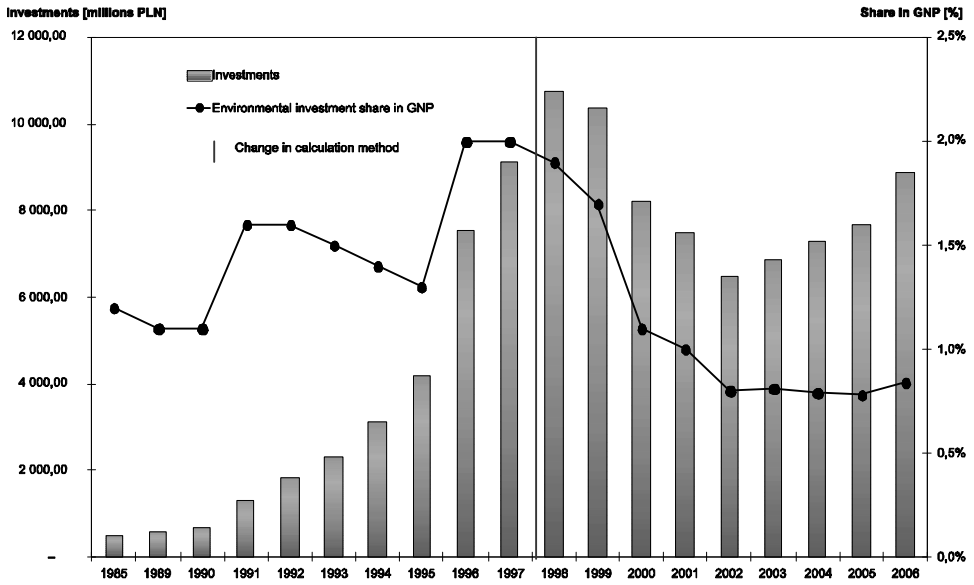

Fig. 2. Environmental investments in Poland in 1995–2006 [mln PLN]
(source: Central Statistical Office)

Rys. 2. Inwestycje środowiskowe w Polsce w latach 1995–2006 [mln PLN] (źródło: GUS)

factor for companies. As a result, the methods for diminishing this cost were searched for, the demand for cleaner and newer technologies rose and, consequently, the environmental investments increased (Fig. 1). From 1998 to 2002 the environmental investments dropped, but since 2003 they have been growing again although at a lower rate than during the period of 1994–1998, when a steep growth was observed.

There are different types of charges:

– fees for pollutants released,
– fees for placing wastes in the landfill,
– fines.

The examples of environmental fees are presented in Table 2 – the levels refer to the year 2008.

Table 2

Environmental fees for chosen substances in Poland in 2008 [PLN]

Substance	Unit	Unit fee in PLN	Unit fee in EUR
Sulfur dioxide (to air)	[kg]	0.43	0.12
Cadmium (to air)	[kg]	154.06	44.02
Benzene (to air)	[kg]	2.01	2.01
Cadmium (to water)	[kg]	100.64	28.75
Waste from metal mining	[t]	15.87	4.53
Waste from copper, zinc and lead mining (tailings)	[t]	9.03	2.58
Flotation waste containing dangerous substances	[t]	50.94	14.55

Source: A government order of 6.06.2007 changing the order about fees for using the environment; 1 EUR = 3.5 PLN

4. Sustainability indicators

The principle of sustainable development is to ensure a better quality of life, now and for the generations to come. It determines factors that sustainable development indicators should take into consideration, as well as the hierarchy of these factors. For the **time horizon** hierarchy (long-term, medium-term, short-term) there are some proposals e.g. LCM (Life Cycle Management), or LCA, and the ecoindicators based on LCA that use different perspectives e.g. hierarchist, egalitarian, individualist like in Eco-indicator99 methodology [3]. For both an **objective area** (environment – planet, economic – profit, social – people) and a **geographical scale** (global, continent, country, local) there are some proposals for prioritisation in the EU regional policy, where the NUTS1-NUTS5 classification is used.[1] The hierarchy for **subject** (entity) is from the most general, i.e. global, through national, sectoral, enterprises and household, down to personal.

[1] NUTS is the hierarchy of administrative geographies used to report statistics across the European Union. In the EURAREA project, analysis was carried out at NUTS3 and either NUTS4 or NUTS5 level. In the UK, NUTS3 corresponds to counties, while at the time of EURAREA NUTS5 corresponded to administrative wards. The size of communes varies considerably between the member states. For some countries NUTS5 is comprised of units which are very detailed (*wards* in UK, *freguesias* in Portugal, *DEDs* in Ireland). In other member states communes are used even if

The design of proper, goal-oriented indicators is not possible without data from individual enterprises, so the proper statistics, a good quality of data secured by the regional databases is of the utmost importance. The importance of good quality statistics has recently been underlined through the support for the research project that aims at improving this area. Here the RAMEA (Regionalized nAMEA-type matrix) project can be mentioned as the project's main target was to develop a NAMEA-type matrix (National Accounting Matrix including Environmental Accounts) on a regional level, to give support to policy makers regarding the definition of sustainable development strategies. The NAMEA-type matrix records the input of natural resources and the output of emissions and wastes with a systematic connection to those economic activities that are directly responsible for the aforementioned input and output. It is a hybrid matrix that includes monetary values in the economic section (NAM) and physical volumes in the environmental one (EA) [4]. Another example of an increased focus on the proper environmental reporting includes the study performed at the request of the Polish Ministry of Environment, i.e. the introduction of rules for the environmental accounting based on Life Cycle analysis in Poland. The aim of the study was to interpret the outcome of Life Cycle Assessment (LCA) in terms of the environmental costs. This attempt ensures the environmental accountability of the products, while LCA ensures the possibility of assessment and quantification of the environmental impact.

The purpose of sustainability indicators is to quantify and illustrate the important issues of progress towards the sustainable development. Being a valuable source of information, they help to establish the strategy as well as to monitor and report the progress. As far as the scientific and technical criteria are concerned, the sustainability indicators should:

- be representative,
- be scientifically valid,
- be simple and easy to interpret,
- show trend over time,
- give early warnings about irreversible trends where possible,
- be sensitive to changes (they are meant to indicate),
- be based on the readily available data, or available at a reasonable cost,
- be based on the adequately documented data, and of known quality,
- be capable of being updated at regular intervals,
- have a target level or guideline against which to compare it,
- be based on reliable data.

The summary of sustainability indicators that fulfil the conditions mentioned above is presented in Tab. 3.

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they are more comparable to units on level 4 in the UK, Portugal etc. This is especially true in northern Europe. The country with the largest NUTS5 units, both in terms of surface area and population, is Sweden (http://eusoils.jrc.it/gisco_dbm/ad/sc/dbm/adsc_do.htm).
NTS1 (NUTS1) – area of the whole country
NTS2 (NUTS2) – region *voivodship*
NTS3 (NUTS3) – subregion
NTS4 (NUTS4) – district
NTS5 (NUTS5) – commune

Table 3

Sustainability indicators main classification

Format	Robust		Transparent		Expanded scope	
Units	Monetary			Non-monetary		
Time horizon	Actual impacts			Potential impact		
Detail	Aggregated, e.g. Human Development Index (UNDP) EPI – Environmental Pressure Indices – EUROSTAT ESI – Environmental Sustainability Index – WEF			Non-aggregated e.g. per capita, unit		
Typology	Descriptive	Performance		Efficiency		Total welfare

Source: authors' work.

The sustainability indicators can be further divided into the following groups:
- goal oriented indicators,
- those regarding the behaviour of enterprises,
- mainstream policy mechanisms,
- green eco-accounting systems.

The framework for the creation of sustainability indicators can be summarised as the transition from the classic Pressure-State-Response model (PSR) to the Driving force--Pressure model (DPSIR), which changes the perspective in which the indicators are created and used. The most important characteristics of the new model was the inclusion of human wellbeing and ecosystem well-being, basing the sustainability indicators on environmental issues or themes.

In the UK the government identified a core set of 150 indicators of sustainable development and 15 headline indicators were chosen. The OECD developed 134 sustainable development indicators (SDI) in 1996. They included social, economic, environmental and institutional indicators and were reduced to 58 in 2001.

The above mentioned RAMEA project realised in the Małopolska region offers support for the life cycle thinking in the environmental policy design and is the response to the needs expressed by the regional policy makers. The project outcome (NAMEA for Małopolska) will create the basis for more effective decision-making (with the emphasis on the relation between economic activities and environmental effects) as well as for further analysis (input-output analysis, sustainability indicators calculation, etc).

Since the NAMEA methodology uses the environmental themes that are similar to environmental impact categories used in Life Cycle Assessment, the paper will show how to use the NAMEA tool together with LCA to develop the sustainability indicators. NAMEA is the system of environmental and economic account that is designed to link the environment and the economy and to identify the most burdensome economic activities/sectors in a country or region. Therefore it is a very good starting point for the sectoral LCA that will provide decision makers with the outlook on the economy, combining the economic and environmental perspective.

5. Conclusions

At the beginning of 2007 JRC organised the 3rd International Life Cycle Thinking Workshop on "Sustainability and Decoupling Indicators: Life cycle based approaches" [5]. The workshop was organised in response to the increased interest in the measurement of the achieved overall degree of sustainability, and the sustainability indicators are the measure that was sought for in policy making, target setting and monitoring. It was also concluded that LCA can be a useful tool for the creation of sustainability indicators but a systemic methodological approach needs to be designed. The main aspects that should be taken into consideration include [6]:

- difficulty in getting information about global effects of national processes,
- using the proper and uniform kind of data (for Europe it can be based on Eurostat, but it could not be compatible with other regions),
- definition of system boundaries,
- definition of functional unit,
- aggregation of data at various levels, especially from micro to macro level (how to elevate LCA from micro to macro level).

The role of LCA was underlined as indicators must account for all the relevant environmental impacts and they must be inclusive; to help avoid the "shifting of burdens" of impacts among e.g. countries and among different types of environment and human health considerations. Therefore, there is a need for further efforts to standardise the LCA methods (for micro and macro level) and underlying data, increase cooperation (capacity building) for data collection, increase efforts to better translate and communicate the LCA results and indicators to key audiences, develop methods to quantify the social value of some of the processes, products and materials, as well as develop advanced methods to calculate a monetary value for some of the key material and energy flow variables wherever feasible and desirable.

Nowadays, different sets of indictors and indices (including social, economic and environmental aspects) are proposed in literature, but to realize the idea of decoupling it would be necessary to assign a monetary value to indicators (greening the GDP). The Life Cycle approach, which requires material and energy flow (which can be expressed also in a monetary value) can be a basis for the calculation on macro and micro level indicator for different products, branches or regions. For the creation of the final methodology results obtained from different techniques (LCA, MFA, IO) should be verified and compared. Moreover, there is also a need to understand context from the perspective of different stakeholders, social and economic conditions.

As there are a lot of socio-economic indicators created for the European Regional Policy, e.g. applied for Structural Funds, which can be used for the creation of sustainable indicators. The criteria are based on the methodology presented in rules and general provisions on the Structural Funds (Council Regulation (EC) No 1260/99 of 21 June 1999 laying down general provisions on the Structural Funds), especially for Objective 2 (contributes to the economic and social conversion of regions in structural difficulties other than those eligible for the new Objective 1. It brings together the former Objectives 2 and 5(b) and other areas facing the need for the economic diversification. Overall, it will cover areas undergoing economic change, declining rural areas, depressed areas dependent on fisheries and urban areas in difficulty). The indicators are, e.g.:

– an unemployment rate above the Community average,
– a higher percentage of jobs in the industrial sector than the Community average,
– a decline in industrial employment.

There is a proposal to improve the sustainability indicators for the Way Forward (UN--DSD, Dec. 2005). The focal point is the design of a small set of indicators that are linked to policy targets, that are goal oriented (for individual enterprise/entity) and based on regional data. It is also important that the environmental and social indicators are compatible with macroeconomic indicators and the budget process. It is worth mentioning that to successfully introduce the sustainability indicators they must be based on regional data:

– emissions (information available in Poland on the per enterprise basis),
– consumption (structure available in Poland on the per month per capita basis).

The goal indicators seem to be the most viable solution to influence the decision--making process on the entity level. The regional databases can be used within the framework of life cycle thinking to support the actual dealing with environmental problems instead of shifting them, as well as to organise the vast amount of information available. The most important application of sustainability indicators:

– inform regional policy makers,
– provide them with a tool to transform the environmental strategy goals into the measures to accomplish them,
– assess the progress and the legitimacy of the implemented environmental policy.

Hence the support for the RAMEA project (Regionalized nAMEA-type matrix).

The first draft version was prepared during the realization of European Waste Management project (EWM), Interreg IIIC, and the final one during the realization of project Municipal waste management system and methods of its assessment used for decision support process No 14-0016-04/2008.

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