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REGIONAL SUSTAINABILITY INDICATORS

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Abstract:
Besides the measuring of global sustainability it is important to discuss the regional sustainability in detail. Regional sustainability can provide useful information for strategic planners for implementing sustainability goals. Many methods have been developed for regional sustainability assessment. Graymore et al. [7] explored ecological footprint, wellbeing assessment, quality of life, ecosystem health and natural resource availability. In my study I examine that from this assessment which is/are suitable for measuring regional sustainability with special regard to ecological footprint which is an officially accepted sustainability indicator in several countries.
Keywords:
regional sustainability, ecological footprint, wellbeing assessment, sustainable society index

1. SUSTAINABILITY - REGIONAL SUSTAINABILITY

The unsustainability and the potentially self-destructive character of the current socioeconomic processes have become a problem to be considered by public opinion and the researchers of environmental issues. It is a scientific fact that these processes can restrict the socioeconomic options in the near future by irreversibly ruining certain unsubstitutable ecosystem services. The humanity determines the level of natural capital[1] by three factors: size of population, consumption and technology. The humanity's effect on environment is appearing in lost of ecosystem services, degradation of biodiversity and deforestation.

The definition of sustainable development has become one of the most common expressions recently. According to the Brundtland Report [3] (also known as Our Common Future), sustainable development requires development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

This definition, however, does not provide proposals for moving towards sustainability, furthermore ignores the limits of growth in connection with population and economy. In addition, the conclusion that the economic growth is sustainable can be drawn. However, the sustainability of environment, society and economy is rather based on physical laws of nature such as the laws of thermodynamics. In my study I concentrate on sustainability in environmental aspect. There are several definitions for environmental sustainability as well, but there are common points, for example the preservation of ecosystem and biodiversity, the creation of equilibrium between inter and intra generations and the restructure of economic system.

The concept of carrying capacity is closely connected with sustainability. Generally, the carrying capacity is the maximum population that can live in long run without a considerable degradation of the area. According to the ecological footprint (detailed later on), the carrying capacity (biocapacity) of the Earth shows that how many resources the Earth can produce in a sustainable way to satisfy human's demand (expressed in global hectare). To achieve sustainability society and economy have to stay within the given area's natural capital. This means humanity's effect on ecosystem must not threat its function, which has an effect on society and humanity well-being and survive. The necessary and sufficient condition of sustainability is that the population can be on or under the level of carrying capacity. Consequently, for humanity sustainability means the life within the carrying capacity of the Earth.

There are some definitions for regional sustainability as well, Graymore et al. 's [7] definition rhymes to the concept of sustainability, namely it „requires the human population to live within the limits of the region's supporting systems (social, economic and ecosystem), ensuring equitable sharing of resources and opportunities for this and future generations in the region". According to Wackernagel and Yount [18], regional sustainability is „the continuous support of human quality of life within a region's ecological carrying capacity".

[1] Natural capital is defined as the stock of environmentally provided assets, which provide a flow of useful goods and services (renewable, non-renewable and generally non-replaceable) [5].

There are several sustainability indicators, maybe the most known are ecological footprint (EF), sustainability society index (SSI), natural resource availability, human development index (HDI), environmental sustainability index (ESI), index for sustainable economic welfare (ISEW), etc. These approaches of sustainability are from different aspects but none of them can fill perfectly the part of sustainability. In my study I am going to emphasize the importance of ecological footprint, because its use is widely accepted.

2. CRITERIA OF REGIONAL SUSTAINABILITY INDICATORS

To choose the adequate indicator for measuring (regional) sustainability, it is necessary to collect the possible indicators. Firstly, I examine which factors and criteria the sustainability indicators have to be suitable for. Then I collect the indicators that can be adequate for measuring regional sustainability. Finally, I study that from the presented indicators which can be used to determine regional sustainability and are suitable for criteria.

As we can see, many sets of indicators exist, but it is important that a sustainability indicator has to be suitable for some criteria. I highlight in Table 1. the main characteristics [2, 7, 12].

Table 1. The main characteristics of sustainability indicators

KERK-MANUEL 2008	BÖHRINGER-JOCHEM 2007	GRAYMORE ET AL. 2008
Relevant	Connection to the definition of sustainability	Assesses regional sustainability
Measurable	Represent holistic fields	Easy use
Recent and regularly updated		Simplifies complexity
Independent from each other		Usefulness
		Information not lost during aggregation of data
Reliable		Transparency
Available data (public sources)		
Available data (for all countries)		

There are several criteria of sustainability indicators. In fact, for measuring regional sustainability it is necessary to choose the relevant indicators from sustainability assessments for which there are adequate data. According to the regional aspect, I use Graymore et al.'s [7] set of criteria which is very detailed (Table 2.) As for regional managers (beyond the former criteria in Table 1.), it is necessary that a regional sustainability indicator has to be related to policy, strategic planning, decision making and be suitable for communication to a range of audiences.

3. POSSIBLE REGIONAL SUSTAINABILITY INDICATORS

For measuring regional sustainability Graymore et al. [7] examined the relevance of five indicators': ecological footprint, wellbeing assessment, quality of life, ecosystem health and natural resource availability. Hereafter I generally present the ecological footprint and wellbeing assessment from these indicators, and complete the list with sustainable society index.

4. ECOLOGICAL FOOTPRINT

The ecological footprint measures humanity's demand on the biosphere in terms of the area of biologically productive land and sea required to provide the resources we use and to absorb our waste (global hectare – gha) [19]. The size of the ecological footprint is connected with the following factors: *population, consumption per capita and technological efficiency in terms of ecology*. The ecological footprint calculation is a multiple-stage process and the indicator can be determined with a simple formula:

$$I = P \bullet C \bullet T$$

where I is Impact, P is Population, C is consumption per capita and T is technology, which is used for consumption and production.

To determine the ecological footprint five major consumption classes are set up: food, home/residence, transport, consumption goods and services. Naturally, to have a more exact analysis these classes can be divided into further classes. Consequently, the ecological footprint helps to determine the available natural capital on the one hand and the ecological consumption of people or community on the other hand, thus we can measure whether the given community is sustainable or unsustainable. In this way it can be proved that social policy is necessary in case of population, consumption and technology (eco-efficiency) [11].

Table 2. Criteria of sustainability assessment methods

A. OVERALL EFFECTIVENESS OF SUSTAINABILITY ASSESSMENT AT REGIONAL SCALE
1. Assesses regional sustainability
•Equity intergenerational and intragenerational
•Level of human activity
•Level of pressure on supporting systems
•Status of supporting systems
◦Ecosystem
◦Social
◦Economic
2. Data availability and accessibility
•Uses existing data
•Data is locatable and accessible
•Data describes the region
•Data collection is cost effective (money and time)
•Ability to assess sustainability without all data
3. Assessment is easy to use
•No complicated calculations
•No specialist knowledge required (e.g. matrices)
•No specialist software required
•Easy to follow method
•Easy to use
•Small indicator set (i.e. manageable data set b40 indicators)
•Not time intensive (i.e. less than 3 months to complete)
B. METHOD
4. Assesses sustainability directly
•Produces an overall sustainability score/index through aggregation of indicator data
•Aggregation method is logical
•Objective assessment of sustainability
•Integrated assessment including relationships between indicators
5. Information not lost during aggregation of data
•Indicator performance is reported
•Sub-system/dimension performance is reported
•Overall system sustainability is reported
6. Transparency in method used to produce results
•Method was clear and well documented
•Easy to understand how final results were derived from indicator data
•Simplifications and assumptions kept to minimum to reduce impact on results
C. USEFULNESS OF RESULTS
7. Simplifies complexity of sustainability and facilitates communication to a range of audiences
•Easy to understand and interpret what results mean for regional sustainability
•Result can be described in a single page report card
•Able to visually represent the results
•Sustainability reported at a range of levels
◦Detailed indicator performance
◦Sub-system/dimension performance
◦Overall system sustainability
8. Usefulness of the sustainability assessment results
•Time and data efficiency of assessment
•For regional managers
◦Sustainability reported at a range of levels
◦Relates to policy, strategic planning, decision making
◦Points out where management actions are needed
◦Targets or thresholds to measure against
◦Can be used to assess trends overtime
•For community capacity building, social learning
◦Result easy to understand
◦Simple to use
◦Data accessible
◦Demonstrates links between sustainability and community activity

There are several criticisms in connection with the EF because there are some weaknesses, but at present there is no tool for sustainability which is complete and none will satisfy everyone perfectly. Furthermore, the ecological sustainability is not absolutely measurable, especially not with a one-dimensional indicator [4, 9, 15]. Nevertheless, based on our present knowledge, we regard *EF as the most comprehensive sustainable indicator and in several countries – Switzerland, Germany and*

Finland – it has become the official sustainable indicator [16].

It is worth noting that nowadays the ecological footprint of humanity exceeds the bio capacity of the Earth (1,8 gha) with 25 %, as large as the ecological deficit. *This means that the demand of the humanity on the biosphere exceeds the carrying capacity of the biosphere* [19]. For this reason, the ecological footprint of humanity has to be decreased below the world-average. According to the estimations, *by 2050, it will have overshot with 200% if the humans do not change their lifestyles and initiate new, environment-friendly technologies, such as solar energy use.*

The ecological footprint per capita is determined by the standard of technology and personal consumption. Thus, the ecological footprint per capita can be reduced by introduction of new technologies. In the literature of sustainability, eco-efficiency[2] has a significant role in relation to technological change; increase of eco-efficiency is regarded as the principal tool of sustainability. An enterprise/national economy is more eco-efficiency than the others if it produces a certain output with less environmental effect. Simultaneously, in the literature the *rebound-effect* is well-known whereby eco-efficiency improvement which resulted by introduction of a new technology may affect against the conservation of resources. At the same time relative eco-efficiency increase, which is induced by technological change, enlarges the scale of biosphere-transformation in absolute amount instead of decreasing it [1].

The ecological footprint is a consumption-based indicator, so the problem of geographical substitution can be eliminated. The ecological footprint considers that developed countries may set out their harmful activities to other (developing) countries.

The main advantage of ecological footprint is that required data is available from standardized database and presents a clear, understandable message that is useful in decision making. The ecological footprint can be measured in global, regional and national level, but in sub-systems data may be unreliable.

5. WELLBEING ASSESSMENT

The wellbeing assessment has been worked out by World Conservation Union (IUCN). This method insures equal weight to people and ecosystem and combines the indicators into a Human Wellbeing Index (HWI), Ecosystem Wellbeing Index (EWI), Wellbeing Index (WI), and Wellbeing/Stress Index (WSI). The subsystems of wellbeing assessment are differentiated in 10 areas (Figure 1).

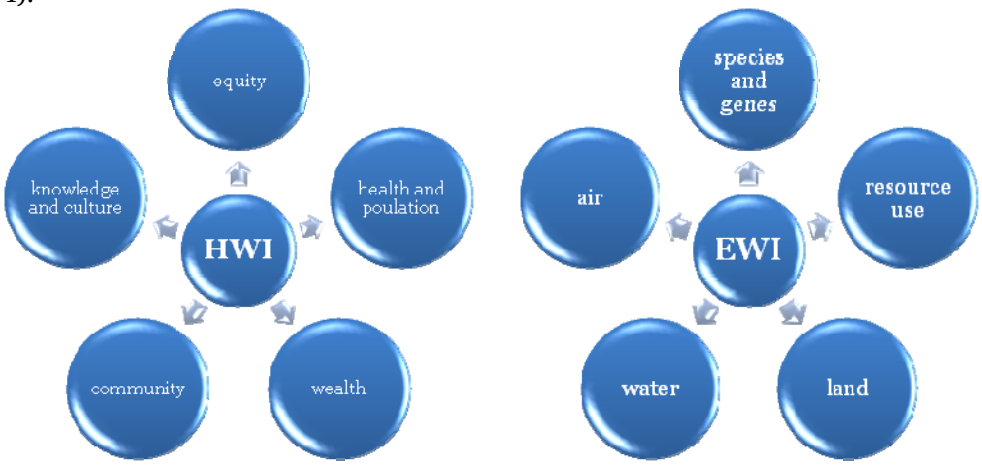

Figure 1. : The subsystems of wellbeing assessment

The IUCN regularly publish reports about problems of environment protection. The Wellbeing of Nations surveys determine 180 countries according to human development and environmental protection. Sweden is in the first place, although the survey also terms it as a country with "ecosystem deficit" and Hungary is in the 44th place. The HWI is a better indicator for measuring socioeconomics conditions than GDP and covers more aspects of human wellbeing than Human Development Index [10]. According to HWI, the report highlights that the world's major population live in countries with poor or bad HWI, furthermore the difference between the minimum and maximum values is rather huge: the median HWI of the top 10% of countries is almost eight times that of the bottom 10% [10]. As far as EWI concern it shows that environmental degradation is widespread. There is no country that has good EWI; almost the half of the countries has poor or bad EWI.

[2] Eco-efficiency is ratio: value of product or service/environmental effect. That is increase of eco-efficiency means augmentation of this ratio.

The WI shows how well societies combine human and ecosystem wellbeing, the WSI is the ratio of human wellbeing to ecosystem stress, in other words the society's effect on environment. The last two indexes highlight that none of the countries is sustainable in the world and also show that generally poverty goes with low demands on ecosystem and inversely. Furthermore, 116 countries of the 180 examined countries are double deficit countries, which mean that they simultaneously have weak environmental performance and inadequate development.

The wellbeing assessment emphasizes that sustainable development is a combination of human and ecosystem wellbeing. The assessment shows that ecosystem wellbeing is very important but the humanity does not deal with the problem sufficiently.

Graymore et al. [7] found that the wellbeing assessment is the most suitable for measuring regional sustainability, considering that this indicator was the only one which met most of the criteria. According to the ecological footprint, the authors emphasized that there were problems with the availability of regional data.

The Wellbeing of Nations report about wellbeing assessment was published only once in 2001, since then there have not been any reports, consequently, annual data cannot be compared in contrast to ecological footprint. Furthermore, wellbeing assessment is based on several indicators, which makes it very complicated.

6. SUSTAINABLE SOCIETY INDEX

The Sustainable Society Index is a newly developed index, which integrates sustainability and quality of life. The SSI is based on public data from scientific research institutes and international organizations (WHO, World Bank, UNESCO, FAO). The SSI consists of 5 categories and 22 indicators (Figure 2).

Figure 2. Categories of SSI

The first calculation was published in 2006, when 150 countries were examined. Then it was updated in 2008. The SSI combines the main aspects of Quality of Life and Sustainability, which are relevant to the development towards sustainability. The index is based on the extended definition of the Brundtland Commission.

According to the results, the high income countries score generally high on the categories of Quality of Life (Personal Development, Healthy Environment and Well-balanced Society) and low on the categories of Sustainability (Sustainable Use of Resources and Sustainable World). On the other hand low income countries show a quite opposite picture. On the list, Africa has the lowest score in the category of Personal Development and Healthy Environment, Well-balanced Society and Sustainable Use of Resources, however. in the category of Sustainable World Africa is the first [12].

In 2008, 151 countries were explored. According to the method, the level of sustainability was measured in 3 steps: the 22 indicators was measured and expressed in a score, then the scores were aggregated into the scores of the mentioned five categories, finally these scores were aggregated into one figure [13]. All scores were expressed on a scale from 0 to 10. The average SSI score was 5, 7 in 2008.

One of the most important disadvantages of SSI is the lack of reliable data, furthermore the disposable data is short for the time being (it covers 2 years).

7. SUMMARY

In my study I presented that it is very important to measure (environmental) sustainability and regional sustainability within. I highlighted that there are several methods to measure sustainability; however, to choose the proper assessment the main criteria has to be clearly defined. I showed the categories of Graymore et al. [7], which is quite detailed and it can help to find the adequate method. I put emphasis on the presentation of three indicators: ecological footprint, wellbeing assessment and sustainable society index. In my opinion ecological footprint can be an adequate indicator for determining regional sustainability.

I think the major problem is that there are countless sustainability indicators and new indicators have been discovered year by year. It would be necessary to choose one indicator which is adequate and to improve it.

The main object of my study was to examine regional sustainablity indicators, because in the near future I would like to test the mentioned indicators and their criteria in the Southern Great Plain in Hungary to measure regional sustainabilty of this area. I would like to study this three indicators based on the list of criteria of Graymore et al. [7].

REFERENCES

[1] Alcott, B. [2005]: Jevons' paradox, Ecological Economics, 54, 9-21.
[2] Böhringer, C. – Jochem, P. E. P. [2007]: Measuring the immeasurable – A survey of sustainability indices, Ecological Economics, 69, 1-8.
[3] Bruntland, G. [1987]: Our Common Future: The World Commission on Environment and Development, Oxford: Oxford University Press
[4] Costanza, R. [2000]: The dynamics of the ecological footprint concept, Ecological Economics, 32: 341-345.
[5] Goodland, R. [1995]: The concept of environmental sustainability, Annual Review of Ecology and Systematicsm, 26, 1-24.
[6] Gonczlik A. [2004]: Az élő természet adományai, Kovász, 1-4, 15–43.
[7] Graymore, M. – Sipe, N. G. – Rickson, R. E. [2008]: Regional sustainability: How useful are current tools of sustainability assessment at the regional scale?, Ecological Economics 67, 362-372.
[8] Graymore, M. [2005]: Journey to sustainability: small regions, sustainable carrying capacity and sustainability assessment methods, Griffith University, Australia
[9] Moffatt, I. [2000]: Ecological footprints and sustainable development, Ecological Economics, 32, 359-362.
[10] Prescott-Allen, R. [2001]: The wellbeing of nations: a country-by-country index of quality of life and the environment. Island Press, Washington
[11] Rees, W. E. [2000]: Eco-footprint analysis: merits and brickbats, Ecological Economics, 32, 371-374.
[12] Van de Kerk, G. – Manuel, A. R. [2008a]: A comprehensive index for a sustainable society: The SSI – the Sustainable Society Index, Ecological Economics, 66, 228-242.
[13] Van de Kerk, G. – Manuel, A. R. [2008b]: Sustainable Society Index 2008, Sustainable Society Foundation
[14] Van de Kerk, G. [2007]: A comprehensive Index for a Sustainable Society (with results shown for 150 countries), Amsterdam Conference 2007
[15] Van den Bergh, J.C.J.M.–Verbruggen, H. [1999]: Spatial sustainability, trade and indicators: an evaluation of the „ecological footprint", Ecological Economics, 1, 61-72.
[16] Vida G. [2007]: Fenntarthatóság és a tudósok felelőssége, Magyar Tudomány, 12, 1600-1606.
[17] Wackernagel, M. - Rees, W. [1996]: Our Ecological Footprint - Reducing Human Impact on the Earth; New Society Publishers, Gabriola Island, BC
[18] Wackernagel, R. – Yount, J. D. [1998]: The ecological footprint: an indicator of progress toward regional sustainability, Environmental Monitoring and Assessment, 51, 511-529.
[19] WWF International [2006]: Living Planet Report 2006, Gland, Switzerland