STUDIA UBB AMBIENTUM, LXI, 1-2, 2016, pp. 129-138
(RECOMMENDED CITATION)

DYNAMIC ASSESSMENT METHODS IN A CHANGING WORLD

Ildiko TULBURE[1,2]*

[1] *University "1 Decembrie 1918", Unirii-Str. 15-17, 510009, Alba Iulia, Romania*
[2] *Clausthal University of Technology, Adolph-Roemer-Str. 2A,*
38678 Clausthal-Zellerfeld, Germany
**Corresponding author: ildiko.tulbure@tu-clausthal.de*

ABSTRACT. For the field of environmental pollution as for the sustainability field there is a need to have direct access not only to specific methodologies by a systematic approach, but also to assessment methods. In the mentioned fields the difficulty is represented by the fact that sometimes it is difficult to establish limit values. Regarding sustainable development there is often the situation of not having limit values, in contradiction to the environmental pollution field, where emission or immision limit values have already been established for most of the pollutants. Establishing development limit values is pretty difficult in all sustainability fields, i.e. economic, environmental and social fields. In the environmental field in most of the cases there are limit values, but in the other two relevant sustainability fields, economic and social field, establishing limit values is not at all easy. This means that nowadays it is pretty difficult to precociously assess if a certain development will assure the sustainability of the considered region. In the last time several discussions have taken place on scientific level regarding the necessity to develop so-called "dynamic assessment methods", in order to make evaluation in those fields where limit values for a certain development cannot be defined or do not exist, as for instance in medical or social fields. The idea behind dynamic assessment methods is actually that different parameter gradients are compared, and not the parameter values themselves. Results will be debated and conclusions concerning the presented methodology will be drawn.

Key words: *environmental pollution, dynamic assessment, limit values*

INTRODUCTION

Presently several global problems are facing the humanity, as stated in Figure 1, which can be grouped in three categories: growth of world population, growth of energy and natural resources consumption and environmental pollution (Jischa, 2005). Beside these so-called "old" global problems, other issues have arisen in the last years and they can be called "new" global problems. For instance issues related to the use of ICTs and the new information society can be mentioned in this category (Tulbure, 2003).

The world began to realize starting with the ‘70 years, in the time of huge technological development, also the dangers and undesired effects of human activities, especially industrial ones. At latest after the Conference for Environment in Stockholm in 1972 and the first report to the Club of Rome „The Limits to Growth“ in 1972 “ (Meadows et al. 1972), it was understood that besides wanted and positive effects of technological progress, also undesired and negative effects can appear. After this time the environmental awareness in the Western world began changing. It was clear that the arisen regional and global environmental problems are very serious and need to be solved.

Worldwide began discussions on political, scientific and social levels in order to find solutions for the problems shown above, which could be applicable with respect to regional differences to the developed as well as to the developing countries. The Brundtland Report of the World Council on Environment and Development represented a result of these worldwide political discussions. The concept of *sustainable development* was defined in the Brundtland Report 1987 and accepted as a possible solution for the global complex ecological, economical, and social problems, as shown in Figure 1:

"Sustainable development means the ability of humanity to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs." (Hauff, 1987).

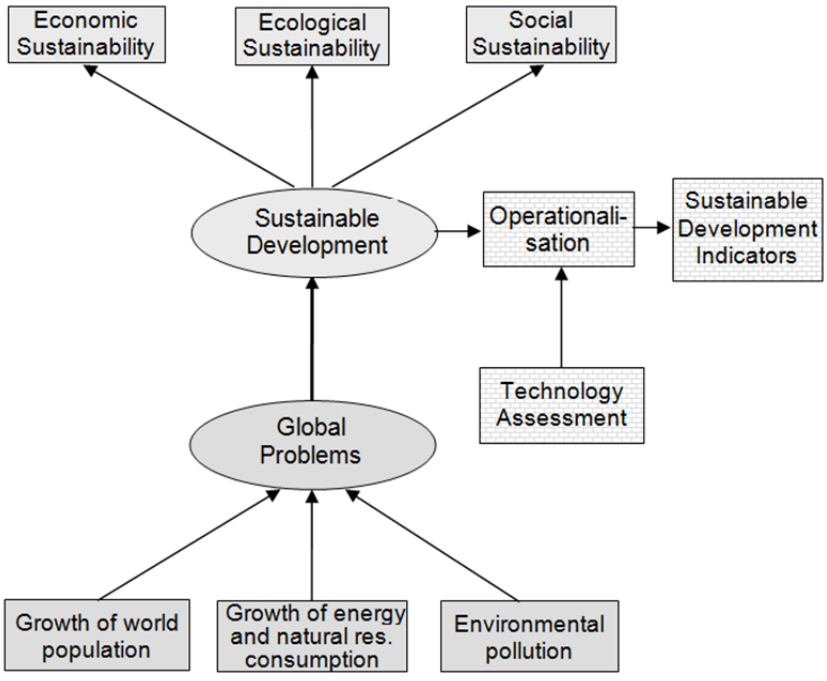

Fig. 1. *Global problems and the concept of sustainable development*

The concept of sustainable development together with its applying forms and understanding patterns was very large discussed on the *United Nations Conference on Environment and Development* in Rio de Janeiro 1992 as well as approached in the closing document *„Agenda 21“*(Engelhardt and Weinzierl, 1993).

Specific sustainable development applying forms and possibilities not only on a global level, but on a regional and local level have been emphasised 2002 during the Johannesburg Conference, called as *Earth Summit*, also known as ”*Rio+10”* - *Conference* (Tulbure, 2013), as well as 2012 during the *"Rio+20"* - *Conference on Sustainable Development*.

Many actions after this time did emphasize that the evolution of technical, social and ecological systems has to be analyzed in synergetic relation (Tulbure, 2003). The general Brundtland definition was worldwide accepted, but alone it does not deliver a concept, that can be applied to the real concrete situations (Lengsfeld et al., 2003).

Sustainable development has become a widely used term today. However, looking in the literature dealing with this topic, the impression arises that there are as many definitions of sustainable development as there are users of the term. In order to make this concept more understandable, rules, strategies and principles of sustainable development have been defined (Tulbure, 1997). The general Brundtland definition has been worldwide accepted, but together with the rules, strategies and principles, it does not deliver a concrete methodology, how to apply it to real concrete situations, especially on local level or even production process levels (Ludwig, 1995).

MATERIAL AND METHOD

The concrete application of the concept of sustainable development for different cases on regional or local level, actually its operationalization, means the transformation or translation of its goals into political measures and controlling instruments, in the form of Sustainable Development Indicators, SDI, as presented in Figure 1. A general methodology in order to concretely apply the concept of sustainable development on regional or local level can be materialized in the following steps (Tulbure, 2013; Jischa 2005):

- defining the sustainability problem;
- establishing the space and time scales;
- systemic approach of the region by modelling the interactions;
- establishing concrete aims for the studied case;
- developing concepts and measures by establishing priorities;
- developing evaluation and controlling instruments, Sustainable Development Indicators;
- verifying the possible results, which could be obtained after introducing the proposed measures, comparing different scenarios;
- applying into the practice the developed concept.

From this methodology follows that for an individual problem-case concrete sustainability aims are generally established, the operationalization being only

possible, when from these aims concrete concepts and measures to achieve them are developed. Sustainability is to be newly defined for each different case. The space and time scales are to be established for each case.

There are several levels to apply the concept of sustainable development. On a global level this means to define general sustainability goals for the whole world, what happened more or less with the Rio - Conferences. On a national level this means to define goals paying attention to the specific conditions of the certain country, these goals and specific measures to achieve them being stated in the National Sustainable Development Strategy of the certain country. On regional or local level concrete measures are stated in the Local Agendas 21 for the respective city.

But what about applying sustainable development on the level of companies, of industrial processes or of products? In this field the operationalization of sustainable development means using new patterns in the form of instruments or tools delivered by the pretty new discipline called Technology Assessment, TA, which did appear at first in the USA (Tulbure, 2013, Jischa, 2005).

Part of what engineers do is to evaluate developments in technology (Jischa, 2005). Their evaluation has up to now almost without exception been focused on technical aspects, like functionality and safety, and on economic aspects following legal and financial boundary conditions. With respect to sustainability more criteria have to be considered like: environmental quality, social and human values, quality of life (Jischa, 2005). This kind of evaluation needs interdisciplinary approaches (Tulbure, 2003). In order to support the activities of engineers when evaluating technologies, Technology Assessment (TA) is delivering specific methods, which should be used, because these are combining different aspects from different fields (VDI-Richtlinie, 2000).

As defined in the German Guideline 3780 (VDI-Richtlinie, 2000), Technology Assessment means the methodical, systematic, organized process of:

- analyzing a technology and its developmental possibilities;
- assessing the direct and indirect technical, economic, health, ecological, human, social and other impacts of this technology and possible alternatives;
- judging these impacts according to defined goals and values, or also demanding further desirable developments;
- deriving possibilities for action and design from this and elaborating these, so that well-founded decisions are possible and can be made and implemented by suitable institutions if need be.

Although in the last 20 years a lot of progress in the field of Technology Assessment has been registered, especially due to several studies which have been carried out in USA, Japan, Germany and other European countries, there is still need in developing integrative methods for Technology Assessment in order to concretely apply the concept of sustainable development (Ludwig, 1995).

There are two strategic possibilities for operationalization of sustainable development (Tulbure, 2003):

- establishing goals on global level, the measures to achieve these goals being prepared on global and national level and applied on regional level;

• establishing goals on regional level, the measures being prepared and applied on regional level; the effects of these measures being evaluated on national and global level too.

As an application example of the first strategy studies in form of scenarios could be mentioned, for instance with the goal of finding future sustainable energy supply systems with minimal effects on the environment. Such a project has been realized at the IIASA (International Institute for Applied Systems Analysis) in Laxenburg/Vienna „Globale Energieperspektiven bis 2050 und darüber hinaus“ (Global Energetic Perspectives till 2050 and more). The IKARUS project (Instruments for Reducing Emissions of Gases relevant to Climate Change) developed by several institutes in Germany represents another example. All these studies base on mathematical models to describe industrial and economic processes; with the help of a database, which describes economic, social and political frame, simulations have been realized and different development scenarios are gained. The goal is to find the right ways for the proposed aims and to help with concrete measures the decision making process (Jischa, 2005).

Many actions in form of Local Agendas 21 do emphasize the second strategy regarding the operationalization of sustainable development. Such Local Agendas 21 have started to be established especially in certain regions or cities in Western-European countries after the Rio-Conference in 1992 and currently are developed in almost all European cities. On this point national scenario studies could also be mentioned, which try to find sustainable ways for the future national development in a global context, for instance the action plan „Sustainable Netherlands“ by Friends of Earth Netherlands in 1992 or the study „Zukunftsfähiges Deutschland“ (Sustainable Germany) initiated from Bund (Friends of Earth - Association for Environment and Nature Protection) and Misereor and led by the Wuppertal Institute for Climate, Environment and Energy (Jischa, 2005).

When going through the given methodology for operationalizing sustainable development one can recognize that many steps can also be identified in the phases distinguished in the definition of Technology Assessment, TA (Tulbure, 2013). Very often a concrete sustainability problem especially related to a technological issue is to be solved by carrying out a TA-study.

On the global level the operationalization means to define general goals for the whole world, things which happened more or less with the Rio-Conferences and the well-known Kyoto-Protocol. On national level the operationalization means to define goals paying attention to the specific conditions of the certain country. On regional or local level concrete measures represent the content of the Local Agendas 21. The field of applying sustainable development on the level of companies, of industrial processes or of products is still in the very beginning in our country and should be done by using analytical instruments of TA (Tulbure, 2003). How do new technologies integrate into environment and society? These questions are in the present conditions of the Eastern European countries from dominant importance, in the process of modernization of old technologies and implementation of new technologies. From this reason TA should play a central role in the future in the next technological, economic, environmental and social development of these countries (Jischa, 2005).

Methodical Problems

Methodical problems appear especially because of the complexity of the analysed processes or do to the complexity of the analysed entities, during sustainability modelling and evaluation. In the process of concretely describing and analysing, as well as evaluating sustainability forms and patterns on regional or local level, difficulties appear do to the missing possibility for a formalistic description of the influencing factors or of the interdependences among them. Shortly said methodical difficulties do result when approaching new sustainability forms and patterns of the human society because there are questions about:

- Handling complexity and uncertainties
- Integrating quantitative and qualitative aspects
- Designing new indicators

New Approaches

With the goal of operationalising sustainability in the last time on different levels did start discussions concerning the existing possibilities to develop new procedures for carrying out a sustainability assessment. In this context first of all the question ”What does it mean enough for the society and for the human being?” has to be newly answered. As it is to be observed this question is a highly aggregated one, including a lot of aspects from social field, as well as from technical, economic and environmental field.

For operationalising sustainability it is necessary to consider different inter-disciplinary aspects in the form of new approaches for succeeding to carry out a Sustainability Assessment, but without having limit values. With this goal it is actually useful to apply so-called *Dynamic Assessment Methods* (Tulbure, 2015).

Currently there is no general agreement regarding an evaluation method, which could be used in order to carry out assessments, in the situations when no limit values can be established, as for instance very often in the environmental, ecological or social field. In this regard, assessing sustainability is a pretty difficult issue, because it is not possible to use precise sustainability evaluation criteria, as regarding sustainable development there are no „reference or limit values“, especially in the social field (Jischa, 2005). This means that in the field of sustainability it is not possible to establish “sustainability reference numbers”, which could be interpreted as reference values and used in order to make comparisons (Jischa, 2005).

In the field of sustainability only changes and developments can be compared, interpreted and evaluated. The question that arises in this regard is connected to the existing possibilities to make comparisons among different developing paths as well as to the existing possibilities to evaluate if a certain developing path is in accordance to sustainable development.

So, if there is no possibility to define some kind of ”reference values” for sustainable development, it follows that only development tendencies can be evaluated. In this regard, scientists from the Finland Futures Research Centre (FFRC) did develop so-called ”*dynamic evaluation methods*” (RANDEurope, 2004). For applying such evaluation methods, some ”postulates” have to be defined and used, in order to compare development tendencies.

Dynamic Assessment Methods for Sustainability Assessment

In the field of Sustainable Development all three fields of Sustainable Development has to be taken into account, as presented in Figure 1. In the following a situation is presented, in which 3 issues are taken into consideration and accordingly evaluated.

For instance, it can be stated that sustainability cannot be achieved without:

Postulate P1: A decrease of Environmental Pollution (EP): **D(EP) < 0**

Postulate P2: A decrease of or at least keeping constant the Energy Consumption (EC): **D(EC) ≤ 0**

Postulate P3: An increase of the Life Quality (LQ): **D(LQ) > 0**

where: D(.) - gradient: $D(X) = (X - X_o)$

X - value of the certain variable in a certain year of the analysis

X_o - value of the certain variable in the starting year of the analysis

Dynamic Assessment Methods applied for the Energy Consumption

Regarding Sustainability Assessment by considering technical aspects, Postulate P2 is becoming relevant, this means that the energy consumption should be taken into account. In this regard in Figure 2 are presented values for the gradients of the energy consumption per capita, ΔE, for different countries.

Considering Postulate P2, three different situations can occur, as follows:

a. if the gradient of the energy consumption is negative, this means $\Delta E < 0$, the development of the considered country is respecting the Sustainable Development;
b. if the gradient of the energy consumption is positive, this means $\Delta E > 0$, the development of the considered country is not respecting the Sustainable Development;
c. if the gradient of the energy consumption is zero, this means $\Delta E = 0$, the development of the considered country is still respecting the Sustainable Development, because at least the energy consumption did not increase in the considered time period.

In order to be relevant such an interpretation have to consider the energy resources, which have been used.

- If fossil fuels have been used as primordial energy resources, then an increase of the energy consumption, $\Delta E > 0$ will have as a result an increase of the environmental pollution and a reduction of available energetic resources, this means that the development of the considered country is not in the direction of Sustainability.
- If renewable energy resources have been used as primordial energy resources, then an increase of the energy consumption, $\Delta E > 0$ will not necessarily have as a result a reduction of available energetic resources and an increase of the environmental pollution, this means that the development of the considered country could be in the direction of Sustainability.
- If the energy consumption will remain constantly from one time period to another, $\Delta E = 0$, this would not necessarily mean respecting the direction of Sustainability, if the percentage of fossil fuels used have not decreased.

RESULTS AND INTERPRETATION

As it can be observed from Figure 2, there are three different cases, as follows:

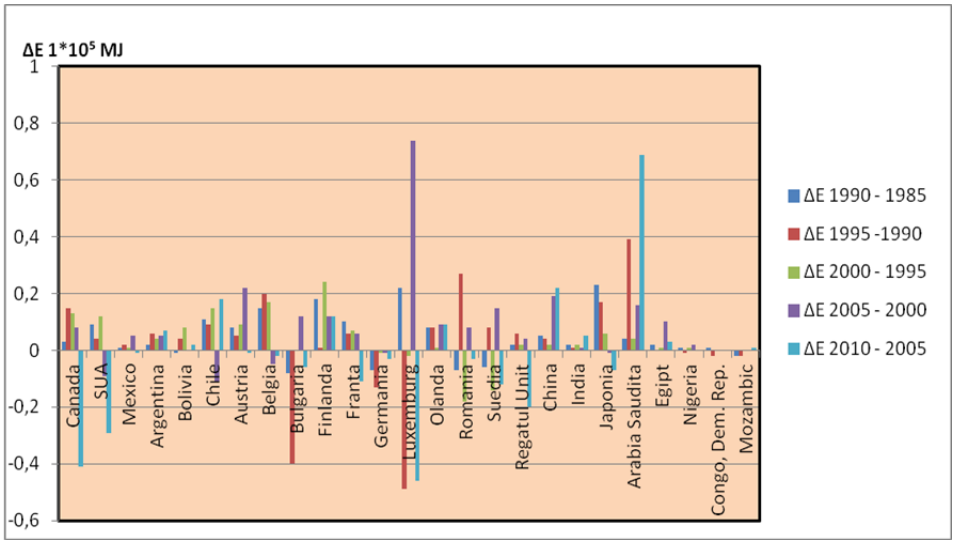

Fig. 2. *Gradients of the energy consumption per capita for different countries*

1. The gradient of the energy consumption is negative, this means: $\Delta E < 0$ – one can recognize the situation a) presented before, what means that the development of the considered country is in the direction of Sustainable Development;

   For instance:
   - for the time period 1985 – 1990: Bulgaria, Germany, Romania et al.;
   - for the time period 1990 - 1995: Bulgaria, Germany et al.;
   - for the time period 1995 - 2000: Germany, Sweden et al.;
   - for the time period 2000 - 2005: Belgium, Chile, Japan, USA et al.;
   - for the time period 2005 - 2010: Canada, Japan, United Kingdom et al..

2. The gradient of the energy consumption is positive, this means: $\Delta E > 0$ – one can recognize the situation b) presented before, what means that the development of the considered country is not respecting the Sustainable Development;

   For instance:
   - for the time period 1985 – 1990: Canada, Finland, India, China et al.;
   - for the time period 1990 - 1995: USA, France, Saudi Arabia et al.;

- for the time period 1995 - 2000: Mexico, Austria, Saudi Arabia et al.;
- for the time period 2000 - 2005: Argentina, Canada, China, India et al.;
- for the time period 2005 - 2010: China, Egypt, Saudi Arabia, Nigeria et al.

3. The gradient of the energy consumption is zero, this means $\Delta E = 0$ - – one can recognize the situation c) presented before, what means that the development of the considered is still respecting the Sustainable Development, because at least the energy consumption did not increase in the considered time period.

CONCLUSIONS

Regarding assessment methods the difficulty is represented by the fact that sometimes it is very difficult to establish limit values, in order to make comparisons, as in several sustainability fields, like in the economic or social field. This means that nowadays it is pretty difficult to precociously assess if a certain development will assure the sustainability of the considered region. In order to overcome this difficulty so-called “dynamic assessment methods” have been developed. Such a Dynamic Assessment Method has been applied regarding the Energy Consumption for several countries, where limit values are indeed very difficult to be established. In the context of this dynamic assessment method different parameter gradients have been compared, and not the parameter values themselves. The gradients of the energy consumption for different countries have been compared and interpreted, as well as conclusions regarding the development trend of the observed countries, if in the direction of Sustainability or not, have been drawn.

From this presentation it clearly follows that there is a need to define new patterns for achieving the sustainability of our society and with this goal, new thinking ways and new visions are needed. One pattern could be represented by the vision of getting a decrease in the energy consumption, as long as most of the energy resources are not renewable ones. Future research work should be carried out in order to clarify the quantification possibilities of EP, EC and LQ on a regional level and to define other postulates as well in order to develop a general Dynamic Assessment Method for Sustainability Assessment.

ACKNOWLEDGEMENT

This work is partially a result of the research project “Methoden zur Entwicklung von Strategien zur nachhaltigen Energieversorgung” carried out in 2011 at the German research institute, Energie-Forschungszentrum Niedersachsen, EFZN (www.efzn.de) and financed by the Alexander von Humboldt-Foundation (www.avh.de), Bonn, Germany.

REFERENCES

Engelhardt W., Weinzierl H., 1993, *Der Erdgipfel*. Economica, Bonn, Germany.

Hauff V. (Ed), 1987, *Our Common Future*, The Brundtland Report of the World Commission on Environment and Development, Oxford Univ. Press, Oxford, UK.

Jischa M.F., 2005, *Herausforderung Zukunft*, 2. Edition, Spektrum, Heidelberg, Germany.

Lengsfeld T., Tulbure I., Ali V. (Eds.), 2003, *Exploring a worthwhile future for all*, A report of tt30 of the Club of Rome, Spanish Chapter of the Club of Rome, Valencia, Spain.

Ludwig B., 1995, *Methoden zur Modellbildung in Technikbewertung*, Doctoral thesis, TU Clausthal, Papierflieger, CUTEC no. 18, Clausthal-Zellerfeld, Germany.

Meadows D., Meadows D., Randers J., Behrens W.W., 1972, *The Limits to Growth*, Universe Book, New York, USA.

RAND Europe, 2004, *TERRA2000 – The 21st Century*, Final Report. Information Society and Sustainable Development. Leiden, Netherlands.

Tulbure I., 1997, *Zustandsbeschreibung und Dynamik umweltrelevanter Systeme*. Doctoral thesis, TU Clausthal; Papierflieger, CUTEC no. 25, Clausthal-Zellerfeld, Germany.

Tulbure I., 2003, *Integrative Modellierung zur Beschreibung von Transformations-prozessen*, VDI-Fortschrittsberichte, **16** (154), VDI-Verlag, Düsseldorf, Germany.

Tulbure I., 2013, *Technology Assessment - Vorlesungsskript*. Lecture Notes. Clausthal University of Technology. Clausthal-Zellerfeld, Germany.

Tulbure I., 2015, *New developing Forms and Pattern for Assuring the Sustainability of our Society*, p. 57-66. In: Vasilescu, C., Flonta, M.,L., Crăciun, I., 2015: *On Form and Pattern*, Academia Publishing House, Bucharest.

VDI-Richtlinie 3780, 2000, *Technikbewertung - Begriffe und Grundlagen*, new edition, VDI Publishing House, Düsseldorf, Germany.