Synthese PODO, Onderzoek naar de mogelijkheden en beperkingen van het concept miliegebruiksruimte, HL/DD/012
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The Environmental Utilisation Space, capabilities and limitations of a concept

1. Summary

The economy extracts materials and energy from the environment, uses and transforms them and finaly emits much of these materials as waste (low entropy) back into the environment. Considering the needs of future generations and the unfulfilled needs of the worlds poor, the pressure on the environment should be limited. Resources are scarse and emissions can have irreversible impacts on the quality of the environment. The funtions or services of nature by which the needs of living beings are fulfilled are at stake. The Environmental Utilisation Space is a quantitative estimate of acceptable pressures exerted by material flows on the environment. Acceptable means: 'consistent with the principles of sustainable development'.
The research focussing on the operationalisation of this concept, was conducted at the Centre for Sustainable Development of the University of Ghent, by three researchers with different scientific backgrounds: Jo Van Assche (sociology), Walter De Jonge (biochemistry) and Bernard Marzijn (agriculture).
The calculation of the Environmental Utilisation Space includes risk assessments. Furthermore questions about the allocation of scarce resources under current and future generations have to be answered. Two basic principles have to be applied: the precautionary principle and the equity-principle.
Given the generaly accepted opinion that sustainable development should build upon the participation of all stakeholders in decision making, the conclusion was that the Environmental Utilisation Space should be an **intersubjective construction**. In a more formal sense the space is modeled with **fuzzy sets**, quantifying the possibilities that the environmental pressures and allocations of material flows are more or less sustainable. **These sets are the result of measurements of preferences, risk perceptions and ethical choises of the stakeholders**. Methods were developed to guide the participatory process that should lead to the construction of these fuzzy sets. Backcasting was identified as an interesting tool to support this process.

2. Objectives

What's at stake

Sustainable Development needs to be guided by indicators which make it possible to evaluate policy and actors, and support decision making in order to make the optimal or satisfying choises. Some indicators should point out whether the use and allocation of natural resources (extraction of materials, emissions of waste) are acceptable, considering the needs of current and future generations. Quantifying the acceptable (what is sustainable) means that tools are needed to handle uncertainties, lack of knowledge, differences in perceptions of risks and the preferences of the stakeholders.

In order to organise and guide sustainable development one needs measurable variables that make it possible to evaluate policy results (ex-post) and policy-choises (ex-ante). These so called Indicators for Sustainable Development (ISD) can or should focus on the ecological, economic and social aspects of the society and its interactions with the environment.
The Environmental Utilisation Space was launched as a performance indicator, quantifying the acceptable pressures on the environment, pressures like extraction of scarse materials and emission of wastes which can damage the quality of the environment.
The concept focuses on the use of the environment, use for the satisfaction of human needs. This use should be constrained, given the fact that the resources are limited and secondly by the fact that they have tot be shared by all people, including future generations. Sustainable development includes a fair (re)distribution of wealth, which means that the Environmental Utilisation Space of a certain economic sector, a population (country, city) or individual, is also constrained by equity-concerns.

Basically the Environmental Utilisation Space is an indicator that must help to evaluate human actions, specifically concerning the use of scarse resources and emissions. However it is not strictly an environmental indicator, while at the same time it focusses on the equity of resource-allocations, which means that socio-economic needs of actual and future generations have to be taken in consideration. Furthermore the results can be influenced by other ethical values, for instance the opinions concerning the rights of living beings other than man.
It should be noted that the concepts like carrying capacity or eco-budget are often but not always operationalised in a manner that comes near to the Environmental Utilisation Space, This confirms the need for such an indicator. The Ecological Footprint is another concept wich focusses attention on the fair distribution of scarse resources. However, while the Ecological Footprint is based on the assumption that different pressures can be aggregated under one denominator – land use- an assumption which can be critisised, the Environmental Utilisation Space is generaly operationaled as a vectorspace whose dimensions represent different material flows (or impactcategories). Aggregation is not really the first concern, although one has to consider the fact for the application of the concept in decision making it might be necessary to weight the different environmental impacts (dimensions).
The Environmental Utilisation Space was introduced in the literature of Sustainable Development by Dutch scientists at the beginning of the nineties. The Western European environmental movement spread it among a broader audience. Generally the calculations are kept relatively simple and are based on a selection of assumptions concerning the pressures nature can stand and some targets considering the equity of resource-distribution.
It is accepted that uncertainties, differences in risk-perception and different viewpoints on equity can alter the results. If these facts are taken into consideration, the result is mostly a calculation of an interval that represents the lower and upper bounds of the estimations of acceptable environmental pressures.
In many cases the interval can be very large. If no indication is given about the probability, possibility or likelyhood that a certain pressure within that interval is more or less acceptable or sustainable, these data can support decisions only to a certain extend. One could say that such an interval would only confirm the fact that the limits are indeed uncertain and that the fairness of distribution depends on many basic assumptions (which demographic projections will be used? Do the rich countries have a historical debt to the poor countries?…).

The researchers involved in this project focus on the uncertainties, differences in preferences and opinions about equity. These concerns however should not result in the frustrating conclusion stating that 'the Environmental Utilisation Space can not be known'. The

Environmental Utilisation Space is indeed a product of human perceptions and ethical or political choises. Measuring the Environmental Utilisation Space than means: measuring the perceptions and ethical choises or preferences of the stakeholders. This approach supports the generally accepted idea that sustainable development should be based on decisions made with participation of all stakeholders or there representatives. At the same time the Enviromental Utilisation Space, like other indicators, forces the decisionmaker to make targets explicit, developments measurable and the choises more rational.

Goals

All aspects adding to the uncertainty when calculating an Environmental Utilisation Space, should be identified and demonstrated: lack of knowledge, differences in riskperception, differences in preferences concerning the satisfaction of needs, different perceptions of equity…An epistemoligical background is needed to facilitate the confrontation with these aspects that complicate the use of this indicator in decision making. An indicator should make sustainability measurable, so a formal (mathemathical) tool is needed to quantify the Environmental Utilistation Space and the uncertainties about it.

Although scientists can support the calculation of the Environmental Utilisation Space with the input of empirical facts (observations, simulations), during calculation many subjective choises have to be made. Basically the assessment of the Environmental Utilisation Space is a risk assessment and an assesment of the equity of resource-distributions.
The aim is to measure the sustainability of material flows (extractions, emissions and distributions among people). Considering all kinds of uncertainties, there is a large international aggreement that sustainability includes the application of the so called precautionary principle. This principle should be operationalised in the calculation of the Environmental Utilisation Space. Accepting this principle does not give a final answer to which risks ar acceptable. It only stresses the need for carefull consideration, and warns us for dangerous technological optimism.
The same goes for equity. Accepting this principle is not enough to know what is fair or not. What is acceptable are not, what is fair or not, remains a question that should be answered by the stakeholders themselves. It is a matter of political choices.
If the stakeholders are asked to make their choise, at least they should be able to assess the consequences of there opinion. This means that such consultations should be supported with tools that make assessments of choises and there consequences possible, including the many uncertainties that are linked to these assessments. For this project, such a tool was sought for the case of greenhouse gas emissions.
Considering the fact that stakeholders are confronted with uncertainties and the necessity of political choises, the researchers concluded that one must confront the stakeholders with some basic theories about decision making which might help them in tackling these problems. Those theories (epistemology, cognitive sciences) can indeed help us. They offer concepts like **intersubjectivity, bounded rationality, satisfying solutions**, etc. These abstract concepts at least give a name and definition of the problems we are confronted with and the answers we should look for. It should be noticed that these concepts are often mentioned in the context of **integrated assessment**, especially by those experts that choose for participatory assessment-procedures.
Building on these theoretical epistemoligical considerations, one can look for the best mathematical (formal) concepts to quantify the Environmental Utilisation Space and the uncertainties that make it difficult to assess.

Targets

In order to support the assessments of material flows by a broad group of participating stakeholders, simple models for the screening of different options (assumptions and political choises) and there consequences are needed.
***Fuzzy sets and fuzzy logic** should be considered as formal tools to quantify the Environmental Utilisation Space.*

Basically one can stick to a simple model to focus on the environmental pressure exerted by material flows, as well as on the distribution of these flows among economic sectors and/or, populations. This model is known as the formula:

Impact = Consumption x Production x Population

Many variants exist (the variables kan have different names), however they all share the general message that the pressure on the environment depends on three factors: the number of people, there (material) wealth and the technology used to create this wealth. Starting with this formula, that can only quantify a state of a certain population or sector at a certain time, a model can be build that focusses on the distribution of the exerted impact among different sectors or groups. Furthermore the same formula can be used to explore future developments. This investigation of the future however should not look for all possible developments (like forecasting models generally do), but should look for the acceptable, wanted and possible developments (backcasting).

Considering the precautionary principle and the fact that subjective ethical or political choises have to be made, one generally assesses the possibility or belief that a certain environmental pressure or material flow is sustainable, and not the probability as is defined in frequentistic statistics. Baysian statistics could be an interesting tool to calculate and quantify the Environmantal Utilisation Space. However the researchers have selected fuzzy set theory (fuzzy logic) to quantify posibilities. This choise is not a statement against Basian statistics. Fuzzy sets were satisfying, so no other mathematical concepts were tested. One of the basic arguments in support of fuzzy sets is the fact that it immediatly focusses on the fuzzyness of properties like 'sustainable', 'acceptable', 'fair', etcetera. So it points to the core of what indicators actually do: measure the extend to which things satisfy certain properties.

Developments

The basic ambitions of the research project were largely based on the assumption that the fundamental aspects of this concept were already investigated quite well, so that work could focus to a large extend on the practical application and popularisation of the Environmantal Utilisation Space.
However it became clear that fundamental research was not complete. These findings let to the conclusion that more time had to be invested in this basic research, reducing the resources spend on practical application and popularisation.

3. Activities and results

3.1. Activities

Year 1: Starting with a screening of the existing literature on the concept itself. It was clear that the Environmental Utilisation Space focusses the attention on the human needs and values, how these needs are satisfied and values are operationalised in terms of material flows and use of natural resources.
Needs, wealth, equity, risk, effectivity, efficiency, scarcity, sufficiency, values, attitude and other relevant items where studied in different scientific contexts (ecological, economic, technological and constructivist research-tradition).

The constructivists view brought the attention on epistemological questions. How do we handle uncertainty and the differences in risk-perception and preferences of the stakeholders? The relation between man and nature can be described in physical terms (material flows): physical pressures of man on nature and physical effects of nature on man. However the relation between man and nature can be conceived in sociological terms (informationflows): man giving a meaning –functions- to nature and percieving risks. Although the relation is quantified in terms of material flows, it is the latter (functions appointed by society and riskperceptions) that steers the calculation of the Environmental Utilisation Space.

Year 2: The importance of these aspects was confirmed by a screening of the literature about climate change.

Attention shifted to risk assessment and the precautionary principle, which – in combinantion with the problem of equity - let to the conclusion that a calculation of the Environmental Utilisation Space is in fact the calculation of some possibility-distribution, which quantifies the sustainability of material flows. These possibility-distributions could take the form of fuzzy sets.

Year 3: The fuzzy sets have to be the result of a participatory proces (co-design), which allows different stakeholders (or there representatives) to feed in there opinions, perceptions and preferences.

In a practical sense the researchers focus on the development of a practical frame that could facilitate the consultations of the stakeholders. This frame should garantee that all relevant aspects are highlighted, while participants must be able to translate there opinions in a way that is quantifiable. Some basic facilitating tools were developed. Concerning climate change (greenhousegasemissions) backcasting proved to be a good support for this participative proces. Backcasting is probably a tool that can be used for the assesment of other problems and material flows related to them.

The study of literature took most of the time, followed by consultation of experts. After year one a report of 300 pages was produced, and experts from different disciplines were invited to read it and give hints for further research.
The experts had no fundamental critique on the content of the report, but often made the right conclusion that in this phase the problems were clearly defined but not really solved.

The research on climate change, risk assessment and the precautionary principle brougt two important tools under attention: fuzzy logic and backcasting.

While for backcasting good basic literature was found quickly (research at the University of Groningen), for fuzzy logic the expertise was available on the University of Ghent. During the last years regular contacts were taken with the mathematicians of Ghent.
However it was clear that the work undertaken was rather unique. Although fuzzy logic has many succesfull practical applications in process control and decision support in business, its use in the domain of sustainable development is at this moment only rare. One can only build on expertise in other domains.

It was decided that the project should not become a mathematical researchproject, but that it should open the dialogue between mathematicians and researchers in the domain of fuzzy logic.
The final report aims to support this dialogue explaining what brings fuzzy logic and sustainable development together. The Environmental Utilisation Space is probably the ideal concept to demonstrate this fruitfull combination.
It should be mentioned that fuzzy logic is already being applied in risk assessment and life cycle analyses.

The study of literature and the consultations of experts were complemented with confrontations with the broader public, in order to test the way in which our findings should be communicated.

3.2 Results

Intermediate results (working papers and lectures)

April 1998: Lecture seminar DWTC (Indicators for Sustainable Development):
'Environmental Utilisation Space and indicators for Sustainable Development'

July 1998: publication of a report with the results of the study of literature (300 pages)

October 28, 1998: Seminar:
'Environmantal Uitilisation Space & Energy Efficiency: a Factor 4?'
With lectures of B. Mazijn and W. De Jonge (see 4.1.5.6 in this paper)

Januari-april, 2000: Cycle of lectures:
'Sustainable Development, Environmantal Utilisation Space and Satisfaction of Needs'
With lectures of W. De Jonge, B. Mazijn and J. Van Assche (see 4.1.5.6 in this paper)

May 2000: Publication of book ' Sustainable Development, a variety of views' (in Dutch) edited by B. Mazijn, with contributions of W. De Jonge, B. Mazijn and J. Van Assche, focussing on the Environmantal Utilisation Space.
(B. Mazijn (ed.), Duurzame Ontwikkeling, meervoudig bekeken, Academia Press, Gent, 2000)

Final results

Final report (target public: decision makers): "Decision making in the Environmental Utilisation Space" (in Dutch), 80 pages

Report and website for educators: "Environmental Utilisation Space and other indicators for Sustainable Development"
November 2000: Workshop with educators: see 4.1.5.6. in this paper

Report and website: The fuzzy logic of sustainability (focussing on methodology of calculating an Environmantal Utilisation Space)
December 2000: Workshop with mathematicians and experts from the domain 'sustainable development'
With contributions of prof. B. De Baets (expert fuzzy logic), prof. E. Kerre (expert fuzzy logic), W. De Jonge. Other contributions were still uncertain at the moment this paper was written.

Workshops and websites have to be considered as a launching platform for propagation and application of the results of the research in decisionmaking and education.

It is difficult to evaluate the impact of the research at this moment. A whole new approach has been developed and as a consequence satisfying mathematical tools were selected to operationalize this approach.
The final result is a methodology that is more complicated, but on the other hand consistent with basic theoretical findings. It is clear that this makes it more difficult to 'sell' to the community. People prefer userfriendly tools. However the researcher think that the method developed is not too complex. Some 'tests' (confrontations with people involved in decisionmaking) have demonstrated that they can indeed learn how it works within one or two hours.
It is clear that decisionmakers and stakeholders should not become mathematicians, but only need to know the basics of the procedures in order to participate in the construction of the Environmental Utilisation Space. It is the dialogue between mathematicians and stakeholders that has to be developed, where the stakeholder must learn what can be calculated and how the results must be interpreted. Which means that they do not have to know in detail how it is calculated.
It took many years before fuzzy logic was accepted as a good instrument to support decisionmaking in business. The problem is always that it is impossible to judge mathematical techniques. One can only judge the way they are used. Statistics is not good or bad, its the application that is sometimes good, sometimes bad.

4. The actors in this research and their collaborations

4.1. The research team

4.1.1. Composition of the team and the research centre

The research on the Environmental Utilisation Space, was conducted at the Centre for Sustainable Development of Ghent University, by three researchers with different scientific backgrounds:
Jo Van Assche (sociology)
Walter De Jonge (biochemistry)
Bernard Marzijn (agriculture)
All three shared experience in the domain of environmental policy and sustainable development.

Professor Ruddy Doom (Third World Studies of the University of Ghent) promoted the research.
During three years, the researchers worked only part-time on this project. Van Assche and De Jonge, spending generally 50 % of a week on this project, Mazijn 10 %.

Van Assche and De Jonge are involved in other research projects, focussing on resource management (De Jonge) and Indicators for Sustainable Development for Cities (Van Assche). Mazijn is president of the centre.

In september 2000, seven researchers were active in the centre. The number of people can change, depending on the projects running.
Administrative support, including library-management is shared with the Department of Third World Studies.

4.1.2. Institutional context

The centre for sustainable development is settled at the University of Ghent. Although residing in the building of the faculty of social and political sciences, it is not specifically bound to any discipline. The center recrutes scientists in accordance with the needs and contents of research projects, mostly projects that need an interdisciplinary approach.
The management is guided by a steering comitee which is attended by scientists from many disciplines of the Ghent University (see 4.1.8). These scientists (mostly professors) act as promotors of the research projects.
The centre provides a course on Sustainable Development, which can be attended by students of the university from different faculties. This course is organised by prof. B. Mazijn, president of the centre. During this course, researchers of the centre present the results of their projects, their methodology etc., confronting the students with problems and practical exercises.

4.1.3. Resources

All resources come from researchfunds, either from the federal (Belgian) government, regional (Flemish) government, provinces or cities. Over a period of five years the total budget was about 35 million Belgian Francs, with an increasing yearly budget, now approaching 10 million Belgian francs a year.

4.1.4. Main activities

The CSD undertakes three sorts of tasks in order to achieve its aims:
- research,
- education and
- provision of a social service.

The educational task is not restricted to giving our own series of lectures, but is broadened to introduce and integrate concepts concerning sustainable development into existing lectures and courses. Furthermore an effort is made to inform and sensitise different social target groups (from outside the university).
Within the framework of the provision of a social service, studies for the preparation of policy and short-term advisory duties are carried out for different levels of government (from international to local).

4.1.5. Output (production)

4.1.5.1. Finished research projects

- Sustainable criteria for development cooperation - environmental aspects
- Comparative investigation of ecological and social criteria within the framework of sustainable development using a case study
- Waste- and emission-prevention as part of environmental protection within companies
- Monitoring the PROSA project
- Conceptual framework for the institutional aspects of sustainable development
- Impact of traffic safety and traffic endurability problems - objective and subjective factors
- Mira-T, research raw materials: wood
- Mira-T, comparison indicators of MIRA-T with indicators of OESO, EEA, CSD, EUROSTAT
- Mira-S 2000, use of raw materials

4.1.5.2. Current research projects

- An integrated approach to chain analysis for the purpose of chain management by companies
- Study of the capabilities and limitations of the concept "environmental utilisation space" (finished end of 2000)
- Towards a carrying capacity for vehicle supported speed management
- Evaluation of the ecological criterion within the support of economic development
- Resource management within the Environmental Utilisation Space

4.1.5.3. Finished social service projects

- Peer-review on the study "LCA on short-cycle PVC-packaging"
- Organisation of the "First International Workshop of Ghent on Indicators of Sustainable Development for Decision-making" (9-11/01/1995)
- Investigating how a province's housekeeping stands in terms of the sustainability factor (for the province East Flanders)
- Investigating the administrative housekeeping within the Ministry of Social Affairs, Public Health and the Environment (in the Vesalius building) for the sustainability factor
- Organisation of the "Second International Workshop of Ghent on Launching the Testing of Indicators of Sustainable Development" (20-22/11/1996)
- Elaborating a barometer for sustainable development within the framework of a local Agenda 21 for Gent
- Democracy in education - education in democracy
- Elaborating a barometer for sustainable development for Antwerp
- Preventive environmental protection at music festivals using the Dranouter Folk Festival as a case study.

4.1.5.4. Current Social Service

- Development of a core set of Indicators for Sustainablity for the city of Antwerp

4.1.5.5. Publications

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BORGO, E., *'Points at issue concerning the construction of a framework for a social and environmental chain analysis'*, Published as a result of the project "A socio-ecologcial approach to chain analysis for the purpose of chain management", Ghent, University of Ghent, Centre for Sustainable development, 1998.

BORGO, E., *'Naar duurzamere productie- en consumptiepatronen ? Over ecologische en sociale labels*', in : Samenleving en politiek, jg. 6/1999, N° 7, pp. 36-42.

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DE MOL, J., *'Hoe doen ze het ? En hoe dikwijls ? Enquête verplaatsingsgedrag Gentse studenten'*, in : Verkeersspecialist, Diegem, Kluwer Editorial, N° 58, pp. 19-20.

DE MOL, J., *'Is het statistisch materiaal even onveilig als het verkeer* ?', in : Verkeersspecialist, Diegem, Kluwer Editorial, N°56, februari 1999, pp. 7-12.

DE MOL, J., *'Slechts het topje van de ijsberg (verkeersonveiligheid in statistieken)*', in : Verkeers-specialist, Diegem, Kluwer Editorial, N°57, maart 1999, pp. 7-12.

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4.1.5.6. Lectures, cycli and seminars (organisation Centre for Sustainable Development)

If speakers are not followed by the name of the institution they represent, it means they are researcher of our centre.

1. Cycle of lectures: Ghent, march-june 1997 (in Dutch)

-Climate Convention (march 19, 1997)
Speaker: **B. Mazijn**

-Agenda 21 (april 23, 1997)
Speakers**: J. Verschooten** (Federal Planbureau), **J. De Smedt** (NRDO-Earth Council en E. Paredis (VODO)
-Forrest Declaration (may 14, 1997)
Speaker: **C. De Schepper** (AMINAL – president coordinating workgroup forrest declaration)
-Biodiversity (may 28, 1997)
Spreaker: **Prof. J. Van Goethem** (KBIN – president coördinating workgroup biodiversity convention)
-International aspects (june 18, 1997)
Speaker: **M. Gedopt** (Belgian ambassador sustainable development)

2. Seminar: Ghent, October 28 1998

Environmental Utilisation Space & Energy Efficiency: a Factor 4?
Speakers: **B. Mazijn, W. De Jonge, P. Hennicke** (Wuppertal Institute Germany)
Debate with **B. Geeraert** (Electrabel) and **J. Vande Putte** (Greenpeace)

3. Cycle of lectures, Ghent, january-february 1999 (in Dutch)

-Sustainable Development and waste- en emissionprevention (january 13, 1999)
Speakers**: B. Mazijn**, **E. Borgo**
-Preventive environmental managementsystems (january 20, 1999)
Speakers : **F. Senesael (**Impulscentrum voor Milieumanagement van de Vlerickschool voor Management), **B. Mazijn**
-Environmental sound processing: de role of the environmental coordinator (january 27, 1999)
Speakers: **R. Dijckmans** (BBT at the Vlaamse Instelling voor Technologisch Onderzoek), **L. De Jager** (ESHER)
-Eco-design: application of life-cycle analysis (february 3, 1999)
Speakers :**B. Mazijn**, **E. Borgo**.
-Applications of productpolicy with environmental goals (february 10, 1999)
Speakers: **M. Pallemaerts** (Free University of Brussels)**, M. De Clercq** (president commision on ecotaxes), **B. Mazijn**

3. Cycle of lectures, Ghent, january-april 2000: Sustainable Development, Environmental Utilisation Space and Satisfaction of Needs (in Dutch)

-Environmental Utilisation Space: operationalising a fuzzy concept (januari 26, 2000)
Speakers: **W. De Jonge, J. Van Assche en B. Mazijn.**
-Basic needs and poverty; Uncertainty an riskpolicy (february 2, 2000)
Sprekers: **R. Doom** (Ghent University)**, P. Gimeno** (Ghent University)
-Legal en economical foundations for international sharing or managing of resources (februari 16, 2000)
Speakers: **L. Lavrijsen/ F.Maes** (Ghent University)**, M. De Clerck** (Ghent University)
-Trade-offs of socio-ecological problems: biodiversity, land use en energy (march 15, 2000)
Speakers: **N. De Pauw, M. Antrop** (Ghent University), **J. Van Assche**

-Foodassurance/Foodsecurity (april 5, 2000)
Speakers: **P. Van Damme, R. Cliquet** (Ghent University)

4. Academic session; fifth anniversary of centre (may 24, 2000)

-Welcome, by J. Willems (rector Ghent University)
-Integrated Assessment, integrated thinking and acting; by J. Rotmans (University Maastricht)
-Sustainable Development, Environmental Utilisation Space and Environmental policyplanning, by A. Verbruggen (Flemish ministry of Environment and Agriculture)
-Refections on Belgian Policy for Sustainable Development, by G. Verhofstadt (prime minister of Belgian government)
- Presentation of the book 'Sustainable Development, a variety of views' (in Dutch), edited by the centre (**B**. **Mazijn**)

5. Planned for november 29, Seminar: Environmental Utilisation Space and other Indicators for Sustainble Development: the need for participation and education

Lectures:
- B. Mazijn: The centre, its research and its expectations concerning education
- W. De Jonge: The environmental Utilisation Space, an intersubjective construction
- J. Van Assche: A core set of indicators for sustainability of a city, co-design with stakeholders
- Block T.: The need for participation and education in integrated assessment (introduction to a debate with actors in de field of education).

4.1.6. Scientific position

The research of the centre is based on input from different scientific disciplines. It is the only Belgian Institute that is specialised in chain analysis, integrating social and environmental aspects.
Concerning road safety, the centre is highly experienced in statistics of road accidents, the research of the carrying capacity of speed policy measures and telematics in cars.
During its five years of existence a large expertise concerning the use of indicators for sustainable development was built up, especially for the local level (city), where the centre seems to be rather exceptional in the way it focusses on the participatory processes that should guide the selection, interpretation and use in decisionmaking of Indicators for Sustainable Development.
The research on complex indicators like the Environmental Utilisation Space and its application in resource management, has led to a unique approach that supports participatory integrated assessment (co-design) of sustainable development. The centre is one of the few in the world that applies specific mathematical techniques like fuzzy logic in this field.
The centre supports the edition of reports concerning the state-of-the-environment and future scenario's of the Flemisch administration (MIRA-T/MIRA-S). It excecuted the analysis of a public survey of the Federal (Belgian) plan for Sustainable Development.

4.1.7. Strategy

While research is based on the study of literature, consultation of experts etc., the educational and social services provide the necessary **contacts with the broader public** and offer a feedback concerning the practical applicability of the findings of the reseach. Especially the development of instruments for participatory decisionmaking (use if indicators, integrated assessment) makes it necessary to find a methodology which makes it possible to tackle quite complex problems, while **keeping procedures understandable by non-professionals**. The education-activities and social services do have an effect on the development of tools and frameworks which must facilitate participatory decision making.

4.1.8. Networking

The centre can always consult experts from the university that support and guide the research policy. Those people ar formally organised in a steering comitee consisting of:

DEPARTEMENT OF PHILOSOPHY AND MORAL SCIENCES

Dr. P. GIMENO
Blandijnberg 2, B-9000 Ghent, BELGIUM
Tel. : -- 32 (0)9/264.39.84.
Fax : -- 32 (0)9/264.41.87.

DEPARTEMENT OF THIRD WORLD STUDIES

Prof. Dr. R. DOOM
Universiteitstraat 8, B-9000 Ghent, BELGIUM
Tel. : -- 32 (0)9/264.69.15.
Fax : -- 32 (0)9/264.69.97.

DEPARTEMENT OF APPLIED ECOLOGY AND ENVIRONMENTAL BIOLOGY

Prof. Dr. N. DE PAUW
Jozef Plateaustraat 22, B-9000 Ghent, BELGIUM
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Fax : -- 32 (0)9/264.41.99.

DEPARTEMENT OF CIVIL LAW

Prof. Dr. H. BOCKEN & Prof. Dr. L. LAVRIJSEN
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Fax : -- 32 (0)9/264.69.90.

DEPARTEMENT OF GENERAL ECONOMICS

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4.1.9. History and Perpectives

The research on indicators for sustainable development has become a important part of the activities of the centre. Combined with experiences in chain management, life cycle analysis, and recently resource management the research is **focussing more on decision support in general** (ex-post, ex-ante evaluation of policy and early warning).
This does not only include a greater interest in tools from **operations research, simulation or artificial intelligence** like multicriteria evaluation, linear programming, backcasting, expert systems, etc. The fundamental problems with uncertainties, lack of knowledge, differences in human preferences and values brought the attention to epistemological issues.
With the conviction that sustainable development should build upon participatory decisionmaking, the centre focusses more and more on learning organisations and integrated assessment that is based on co-design (with participation of the stakeholders).
The research on the Environmental Utilisation Space and Core Indicator Sets for cities have played a crucial role in this evolution of interests.
As a consequence the centre is building up contacts with specialists is decision support and integrated assessment, in Belgium and abroad.

4.2 Place and meaning of the project for the other activities of the researchers

The results of this project – the methodology developed- can be applied in a situation where the calculation of the Environmental Utilisation Space is the final goal. However this 'space' can be the starting point for further research in the field of resource management. One could consider the space as a discription of the constraints one has to respect when looking for an optimal or satifying allocation of resources. Furthermore it is possible to use the Environmental Utilisation Space as a performance indicator to estimate the potential of technological innovation. These extensions are now investigated by the centre in a researchproject with the title 'Resource Management in the Environmental Utilisation Space' (funded by the Flemish government).

This project links the use of this concept with Material Flow Analyses. Furthermore the researchprojects try to identify a way to use the Environmental Utilisation Space in integrated assessments that focus not only on the environmental issues, but also on the social and economical aspects of sustainable development. One of the problems of this research is the valorisation of trade offs between and inside social, economic and natural capital.

There is also a more general effect of this project on the research of the centre. **The way in which participation of the stakeholders was operationalised has an impact on all research on Indicators for Sustainable Development**. The focus on epistemological problems and the practical answers found in fuzzy logic have an impact on the way indicators are used (selected, interpreted and used in decisionmaking).

5. Evaluation and perspectives

5.1. Evaluation of project

Each calculation of the Environmental Utilisation Space is the result of subjective (political) choises. Some people might not agree with this, stating that the any calculation is largely based on empirical facts. The input of empirical facts is indeed important. However choises have to be made concerning the risks that are acceptable. Furthermore the allocation of scarse resources among people and economic sectors (needs) is also a matter of choises, in which the operationalisation of the equity-principle can lead to many different results.
It is somethimes understood that subjective calculations can not support policy, so one needs objective data. It is dangerous to reduce the debate to the question whether the Environmental Utilisation Space is either subjective or objective. We concluded that **a third kind of knowledge needs more attention. This is the intersubjective construction.** The Environmental Utilisation Space is a manmade construction, based on empirical input, risk assessments (and perceptions), ethical choises (equity) and preferences concerning the satisfaction of needs. 'Intersubjective' means, that the construction can be used collectively and that is is conform to the public opinion. Although subjective, the calculation should be accepted or supported by many stakeholders.
In a more formal sense the researchers found that the mathematical concept 'fuzzy set' could offer a tool for visualiszing this intersubjective construction. The fuzzy set quantifies the possibilities that material flows are less or more sustainable. The construction than is based on measurements of risk-perceptions, the consequences of ethical choises and the preferences of the stakeholders.

This approach is quite new and can have an **impact on the methods used in integrated assessment and resource management. It supports a participatory proces**, which is many times advised, but however difficult to implement when complex problems arise. While many stakeholders can indeed communicate their points of view and interests to policymakers, there role is until now generally marginal when it comes to the operationalisation of indicators and calculation of targets. In most cases different stakeholders set different targets. If a consensus is found it is generally a short term goal, putting long term considerations on the shelf.
With fuzzy logic it might be possible to find a **resolution for the conflicting views** concerning long term goals.

This approach gives a double role to the scientist: first he or she remains an important **contributer of empirical facts** which can or must be used as input for the calculation of the Environmental Utilisation Space. Second he or she can play the role of **facilitator**, guiding the

debate in which stakeholders make their choises. This asks for the development of methods that make a representative collection of perceptions and preferences possible. Finally one needs tools to analyse these opinions in order to construct a fuzzy Environmental Utilisation Space.

So far this research project has developed the theoretical frame for this approach, identified a way to operationalise it (fuzzy sets), and made the first basic steps to work out a procedure to consult the stakeholders (supporting the debate with backcastingmodels) . The latter is largely based on a casestudy about climate change (greenhousegas-emissions, consumption of fossil fuels). It is quite possible that certain material flows need adapted procedures, although one might expect that backcasting offers a method that can be applied for many material flows.

5.2. Perspectives

The analyses of the preferences and choises of the stakeholders can be refined. In our opinion that reseach needs support of researchers with a background in mathematicians (experts operations research, fuzzy logic). However the refinement of the mathematical tools should be guided by consultations of the people that use those tools.

On three occasions intermediate results of the research were presented to a wider audience. Generally the audience was confronted only with the theoretical aspects, focussing on uncertainties, subjective choises, etc. This is however only a first step. Theory brings us to the right questions that should be answered. Solving those questions however is another thing. This research has selected specific mathematical tools tot tackle the problem. These techniques are however not simple to communicate to a wide audience, especially when it is assumed that a lecture should not take more dan 30 minutes.
The researchers than changed their strategy and focust on a smaller audiances: actors which could play an important role in the application of a concept like the Environmental Utilisation Space.
First there are the people active in education. One can always confront the broad public with the results of calculations of the Environmental Utilisation Space, hoping that these data will convince them to adapt their livestyle. However, while each calculation can in a sense be criticised, one could shift to the methods developed in this project in order to produce a more general assessment (screening) of the limits that earth imposes on consumption and production. It might than be appropriate to present the concept in an educational frame that makes it possible for the public to experiment themselves with the different choises that can be made concerning the acceptability of risk, fair distribution of resources, etcetera. This changes their final position. No longer do they have to believe that one or another calculation is correct, or do they have to choose between the views of one or another stakeholder (environmental movement or industry). They can develop a more general and critical view on the possibilities that certain lifestyles are more or less sustainable. At the same time the broad public could learn more about the basic problems known in risk assessment, about uncertanties and the lack of knowledge in general, the precautionary principle, equity etc…
The researchers of this project concluded that professionals in education should be confronted with these opportunities. A seminar is organised (see 5.1.5.6 (5)) and a website is started focussing on the Environmental Utilisation Space, Indicators for Sustainable Development in general, partcipation, decision making and integrated assessment. Instead of producing the final education material concerning the Environmental Utilisation Space, the researchers prefered to launch a proces in the field of education that focusses on the broader knowledge and capacities **people need to develop a critical view on indicators** and there use in decisionmaking.

Secondly, another aspect needs attention. This concerns the **application of mathematical instruments** like fuzzy logic in the domain of sustainable development. The researchers found that in this case it was necesarry to organise a platform where mathematicians can meet professionals and semi-professionals in the domain of sustainable development.
When people from government administrations or stakeholders like industry and environmantal movement are confonted with these instruments, it is clear that this is quite new to them. Mathematics is a discipline from which the practical methods applied in decision making (operations research, simulation, expert ssytems,…) or only known by insiders. Although one must not expect that everyone should learn these techniques, at least those involved in decision making should know what mathematics can do and what it can not do.
Therefore a platform was created to tackle these problems, focussing on the application of fuzzy logic in sustainable development. The ambitions for the future are to organise an international network in this field.

5.3. Evaluation of PODO

PODO made **fundamental (theoretical) research** possible. The research on the Environmental Utilisation Space has shown that this was necessary. If one had asked only for concrete data - calculations of the Environmental Utilisation Space - the outcome would probably have been completely different. In that situation the result would probably have been an implementation of simple procedures, surrounded by proza stating that the results are hypothetical. Such results are already produced abroad and do not need endless repetition.
The fact that PODO made fundamental research possible provided the means to develop a whole new methodology in this field.
On could conclude that the operationalisation of the precautionary principle, equity and participation in decision making is a problem that needs more attention, especially the **translation of the theoretical considerations, into practical methods for decision making** is not yet fully developed. There exists pioneering casestudies in this field, but the Centre of Sustainable Development has the impression that until now only few people are aware of them and that the application and testing of these methods in policy needs more promotion.

On the other hand concrete data (calculations) are also needed and the researchers do hope to find the resources to apply their methods in order to produce those data.
It is clear that the production of complex indicators like the Environmental Utilisation Space and there calculation, using input from different stakeholders, askes for mathematical expertise. The method developed so far can be refined, although this does not mean that one has to wait for these refinements, in order to make calculations. The method that is developed now can be used as a basis to compare whith more refined methods.
For the future it might be important to **promote cooperations between mathematicians and experts in the domain of sustainable development**. The researchers found that the mathematicians have a lot of interesting tools which can support decisionmaking, especially when it is the ambition to organise an participatory integrated assessment of sustainable development.