International Society for Ecological Economics, ISEE Russian Chapter

Russian Academy of Sciences, Program Systems Institute (Pereslavl-Zalessky), Control Processes Research Centre

University of Pereslavl-Zalessky

Russian Ministry for Environment Protection and Natural Resources

Tilburg University, Department of Leisure Studies, European Centre for Nature Conservation

ZEW - Centre for European Economic Research (Mannheim), Department of Environmental and Resource Economics, Logistics

Second International Conference of the ISEE Russian Chapter

SOCIO-ECOLOGICAL-ECONOMIC SYSTEMS: FROM INFORMATION AND SIMULATION TO PRACTICAL SOLUTIONS

July 16-21, 1995

Pereslavl-Zalessky, Russia

ABSTRACTS

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Purpose of the Meeting

The second Workshop of the ISEE Russian Chapter again takes place in Pereslavl-Zalessky. The first meeting *"The Role of Information Sciences in Regional Development"* (July 1993) was held at the Institute of Control Sciences, Russian Academy of Sciences (Moscow) and was continued in Pereslavl-Zalessky at the Program Systems Institute.

The Workshop is foreseen as an extended meeting of those ISEE members and other academic, governmental and NGO's individuals from worldwide, who are interested to invest some ideas of ecological economics into the regional development. One of the particular goals of the Workshop is to give an international independent expertise of the state of Russian socio-economic and environmental situation, and help in elaboration of strategies for future development.

Scope

The Workshop is focused mainly on:

1. Control of Regional Systems
2. Environment, Institutions and Society
3. Ecological-Economics Modelling
4. Social Ecology
5. Problems of Sustainable Development
6. Indicators of Sustainability
7. Natural Resource Accounts
8. Information Systems

Language

The working language of the Workshop is English.

Venue

The Workshop is held at the Program Systems Institute near the town of Pereslavl-Zalessky on the bank of Plescheevo Lake. Pereslavl-Zalessky is one of the ancient towns of Russia, located at a 130 km distance from Moscow.

Editor of the volume: Paul Safonov

ABSTRACTS

INTERACTIONS BETWEEN SOCIO-ECONOMIC INDICATORS AND ECOSYSTEM HEALTH IN PRIVATELY OWNED PROTECTED ZONES IN COSTA RICA: CAN SUSTAINABLE CONSERVATION OF NATURAL RESOURCES BE ACHIEVED WITHOUT EQUITY?

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There is a growing body of literature in Ecological Economics which explores the links between ecosystem health and socioeconomic factors. Of special interest is the relation between equity and environmental degradation. A lot remains to be explored, specially in the area of land tenure regimes as a facilitating factor for natural resource base conservation.

Costa Rica has approximately 25% of its area under some conservation regime . During the last decade the trend to use alternative models, which allow for private property management within protected areas, has become prevalent. This results from the overall tendency that prevails in developing nations to turn to the private sector in order to undertake activities which the governments can no longer fund. Other traditional models of protected areas, such as the protected zone model in Costa Rica, are used in situations where the state does not have enough resources to fund confiscations through the right of eminent domain. In this model, ownership also remains private and productive activities are regulated so the hydrological resources and the quality of the soil are conserved. This last model has been diagnosed as lacking effectiveness in the implementation of its objectives. What factors determine the difficulty to manage protected zones in Costa Rica? Is it just the conflict between state objectives and private property or do the history of land tenure and other socioeconomic factors have an influence? This study explores the correlation between ecosystem health, understood as a biophysical phenomenon and socioeconomic factors. Indicators of vigor, resilience and organization are included in an index of ecosystem health. Socioeconomic factor indicators include a Gini coefficient for land distribution, income per household, population density and illiteracy rates amongst others.

Results suggest a negative correlation between higher land concentration and ecosystem health. A significant correlation was found between higher levels of ecosystem health and areas that have higher illiteracy rates and have been recently created. Such results illustrate the pressure that exists over these areas in more urbanized areas. Many ofthe older protected zones were created to protect the water resources of the Central Valley in Costa Rica, where more than one third of the country's population lives.

These findings could justify the implementation of more holistic policies to address conservation problems in developing nations. It seems that agencies dealing with land distribution and zoning should be involved in the processes of creation and management of these areas.

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INVESTMENTS IN EDUCATION AND REGIONAL DEVELOPMENT

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The report is devoted to the description of a macromodel of a city (a region), enabling to study influence of the investments in education and regional tax policy on economic and social development of a region.

Social stability has the important significance for steadiness of evolutionary development. First of all, we connect it with employment of the population and the youth as a most active part of population. Obviously, the investments in education directly influence on employment of this group. Though the unemployment of the youth - not all unemployment, but taking a useful activity to the youth, we remove a level of unemployment from dangerous feature and we increase probability of evolutionary development of an economy and society.

At construction of model the following assumptions were made:

1. Jump in the prices on January 1, 1992, and the subsequent inflation are reflected in the model by function of inflation;
2. The disorder of a uniform economic complex of USSR, establishment of a new bank and financial gear, transition from scheduled manufacture to market have resulted in crisis of payments. As a result the economy of Russia is in transient from one gear of functioning to other. We set the duration of this process with the help of so called destruction function;
3. Parameter of social intensity in model was connected with employment of the youth. Rigidly supposed, that the education is an employment of this group.

As model variables were chosen:

L(t) - population of a region,

N(t) - engaged population,

w(t) - fixed assets,

u(t) - gain of productivity,

s(t) - parameter of life quality.

Dynamics of the model variables is described with the help of a system of ordinary differential equations. The model was identified on a data of socio and economic development of Pereslavl-Zalessky. The forecasts of development for the various scripts of inflationary growth and rates of recession of destruction function are obtained. Optimum distributions of the tax rates and share of the budget on support of education with proceeding from criterion of maximum growth of a parameter of life quality were found.

The software was developed for macromodel submitted. The block of obtaining of optimum parameters of the model is executed in such manner that the set of optimized parameters and one of several criteria of optimization are chosen in a dialogue mode. Within the framework of this software association of the macromodel at the level of information exchange "results of modeling" - "initial data" with balance diversified model of region development is supposed in future.

OPTIMIZATION OF PRICES AND PRODUCTIVITY OF TECHNOLOGICAL SYSTEMS

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A technological system can be considered as a dealer between a producer of raw materials and consumer of this system output. Flows of raw materials and output products are determined by prices set by dealer; dealer's profit depends on the prices and the flows.

In this paper the optimum conditions for prices and flows are obtained. It is shown when the passage to nonstationary regimes is appropriate and which type of optimal solution takes place in this case. For solving such a problem the technique of averaged optimization is used. The analogy between problems on flows control in economics and problems on irreversible systems thermodynamics is emphasization of prices and productivity of technological systems.

COLLECTION AND RECYCLING OF MUNICIPAL SOLID WASTE IN ISRAEL, ANALYSES OF ALTERNATIVES

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The disposal of municipal solid waste causes economic and environmental burdens in Israel. The different aspects of recycling, including technological aspects of the recyclable materials and economical aspects of waste management were studied.

A computerized spread sheet model was developed, using data obtained from recycling companies in Israel and the Municipal Authorities Organization. The model enables each municipality use its data in order to evaluate anticipated costs of different waste management alternatives. The data include collection costs, transportation costs, processing costs and landfill tipping fees. It was found that "traditional recycling", such as curbside, drop-off centers etc., for the collection of recyclables is economically sound only if landfill tipping fee are higher than 30$/ton (under specific data).

Since organic kitchen waste comprises about 50% of the municipal solid waste in Israel, this abundance of potentially recoverable material forms a large and important resource.

The wet-dry source separation option includes composting of the wet stream and separation of recyclable components at a material recovery facility (MRF). This is the optimal for landfill tipping fee for excluding 15$/ton.

Presently, there is no direct nor indirect incentive for the individual household, to reduce, reuse or recycle its waste. Economic incentives in solid waste management policies in several western countries were studied. Some of these incentives can be implemented in Israel as a part of a national integrated waste management policy.

SOCIO-ECOLOGICAL INDICATORS FOR SUSTAINABILITY

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A systematic framework of indicators for sustainability is presented.

In our approach there is an emphasis on societal activities that affect nature and on the internal societal resource use, as opposed to environmental quality indicators. In this way the indicators may give a warning signal to an unsustainable use of

resources early in the chain from causes in societal activities to environmental effects. The aim is that these socio-ecological indicators shall serve as a tool in planning and decision-making processes at various administrative levels in society. The formulation of the indicators is made with respect to four principles of sustainability, which lead to four complementary sets of indicators. The first deals with the societal use of lithospheric material. The second deals with emissions of compounds produced in society. The third set of indicators concerns societal manipulation of nature and the long-term productivity of ecosystems.

Finally, the fourth set deals with the efficiency of the internal societal resource use, which includes indicators for a just distribution of resources.

INFORMATION TECHNOLOGIES IN ESTIMATIONS OF INFLUENCE ON ENVIRONMENT (EIE)

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In order to create effective ecological-economic strategies of territory control, it is necessary to carry out the "estimation of influence on environment" (EIE) possibly on more early stage of project realization. It requires to work out expert systems for short-term and long-term prognosis of environment condition.

Quick and reliable influence estimation can be only done on the basis of analysis of large information volume and by the use of mathematical models of interaction processes between technological object and environment. EIE include following stages:

- description of environment condition by complex vector, which includes aggregated factors of atmosphere, hydrosphere, soil-ground and bioresources conditions;
- classification of repressive and restorational influence on environment for selection technology object; and definition of input vector, which contain generalized factors of industrial influences on ecosurroundings;
- definition of factors and criteria of ecosurroundings stability to industrial influences and methods of it definition;
- development of factorial, physicochemical models of environmental interaction and biology population models of different territorial and time scale;
- development of methods, algorithms and programs for computer analysis of influence with the use of modern geographical information systems (GIS).

On the basis of this influence analysis it is possible to determine rates and criteria of rational load on territory, to divine rational object location, and to select most dangerous technologies, as well as methods of their improvement.

THE IMPACT OF ENVIRONMENTAL QUALITY ON TRADE FLOWS

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This paper analyzes the impact of environmental quality on bilateral trade flows. Within the framework of a gravity model the effects of environmental indicators on bilateral trade flows are estimated for the years 1991 and 1992. Empirical studies on environmental influences on foreign trade are not very numerous. We use a simple gravity model incorporating Energy variables to analyze their influence of Energy on Bilateral Trade Flows. We distinguish between the Energy intensity of trade flows of the European Union, the EFTA countries and East European nations to investigate how a stronger environmental policy in these groups of countries will work out.

INFORMATION SYSTEM FOR SUBSTANCE FLOWS

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In November 1993 a large five year research program started, focused on substance flows of five heavy metals through economy and environment on Dutch and European scale. In the program six groups at four Dutch universities are involved. The rationale of this research is the concern about the ever growing influx into the economic system which, eventually, poses risks to the environment.

Within the framework of the program a Substance Flow Information and Calculation System (Dutch acronym RIS) is being developed at the IES to support and integrate the different studies within the research. The IES is the Institute for Environmental Studies at the Vrije Universiteit, Amsterdam.

The objectives of RIS are:

1. Organization and documentation of empirical data for stocks and flows.
2. Static simulation of substance flows through economy and environment
3. Linkage to models addressing specifically economic and environmental aspects
4. Organization of data about socio-economic development, possible measures and technological change.
5. Dynamic simulation of changes in stocks and flows, simulation of linkages between flows due to substitution and technological change.

The substance flows are represented as a network with nodes and flows. The subject of a flow usually is a good or material. After definition of the composition of the goods and materials networks for one or more target substances can be derived. Such a network, where the law of conservation of mass holds, is defined as a substance account.

The nodes of the network represent economic or environmental units where inflows are transformed to outflows. In a node accumulation or depletion can take place, which determines the size of the stocks for that node. Nodes have an economic/environmental, a technical and a geographical attribute.

RIS also enables documentation of empirical data. It comprises (elaborate) comments and literature references linked to specific nodes and flows. The literature module documents on which literature data is based, and vice versa, for what data a piece of literature is used.

The features mentioned so far are included in the developed first version of RIS, meeting the first and second objectives. At the moment we are working on satisfying the other objectives; linking to other models and dynamisation of the model. The Database Management Program FoxPro 2.6 for Windows is used for the relational database and we are planning to use C++ for the calculation model. An important technical aspect is the application of evolutionary system development. In this way the system is extended and improved step by step by continuous contribution of the project partners with ideas and comments.

THEORY OF QUALITIES AND PROBLEMS OF ECOLOGICAL ECONOMIC ESTIMATIONS

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The quality of environment in the industrial city can be considered as a result of interaction between the society and nature. A man changes the nature and on the other hand he is under the anthropogenic impact, which was created by himself, accumulating in its own body all negative changing

So the man himself has to estimate quality of environment, quality of his health and quality of made by him technological processes and finds the optimal ways for improvement of all those factors, taking into account all economic possibilities and levels.

The matter of the report is demonstration of the new approach to systematically description and estimation of ecological economic systems. Method of investigations is based on the theory of qualities developed by one of the authors which presents mathematical instrument for a quantitative evaluation of qualities and preference systems simulating.

A choice problem is known to be one of the main types of intellectual activities of any human being or the community. A number of approaches and scientific researches such as the theory of the decision-making, the utility theory, the methods of multipurpose optimization have been developed. The terminology, setting up of tasks, a number of situation involved and

other characteristics of these fields of knowledge partially intersect and in general supplement each other so that they can be considered as a complex of problems and different ways of their solution.

In spite of rather significant results available in this advanced scientific area, these approaches suffer, from our point of view, from the following noticeable shortcomings:

- not entirely clear discrimination between properties and qualities of the object under consideration, and lack of special quality scale;
- absence of common quality criterion theory, and as a result rather narrow and not always adequate choice of such criterion, the problem of the equivalent criteria etc.

In the proposed theory, quality as a methodological category has got some interconnected but functionally various and mathematically defined interpretations:

- some definite region in the object property space, so the object can't be the same when it loses its quality, that is its representative point leaves the region of its quality;
- the level (degree) of conformity of functional characteristics of an object to some clear defined requirements;
- the degree of object acceptability for the consumer, purchaser, expert, customer; as the preference systems are various for different people, the quality in such a sense will be also various for them.

Nevertheless this last interpretation of the term quality is not purely subjective as the value usually represents the interests of the system and must define the quality as the degree of satisfying the requirements of this system, which are usually reflected by the state of mind of the expert. In this sense quality is psycho-systematic notion.

The preferences are formally represented by digits in the so-called quality scale which is divided into intervals "unsatisfactory", "normal", "excellent". Any separate quality of the object under evaluation must be presented in this scale in order to achieve a standard meaning for all situations.

The general quality of the object is represented as a special function of its partial qualities, which must be chosen from a constructed class of so-called average functions, i.e. functions of n variables, the meanings of which are always in the interval between the meanings of their arguments. Such choice keeps the belonging of general quality criterion to the same scale as separate qualities belong to providing uniform interpretation of the meanings obtained. In addition, the problem of criteria equivalence is removed: criteria are equivalent only when functions expressing them are identical.

Consulting with experts and specialists gives to knowledge engineer a proper information for constructing mathematical model of their system of preferences. The complex of physical and other properties of an object can be presented in its property space and then, on the base of the model, in the quality space, and finally on the common scale of quality. Comparison of numeric meanings of qualities of different objects gives the possibility for evaluation and decision making.

The development of the method of a quantitative evaluation allows to make the applied mechanism of ecological condition of the town districts, fixing the starting price, rate payment, taxes, ecology insurance tariff. This mechanism can be an information basis for the development of the balanced civilized state and private relations when using database about the conditions and properties of the objects and software for solution making by means of best variant search.

The results of differentiation of city territory of Volzhsky (Volgograd region), which are based on ecological economic evaluations will be presented, and some problems of their including them into a more common system evaluation will be discussed.

THE INCENTIVES SYSTEMS AND THE COMMAND AND CONTROL APPROACHES USED TO PROTECT OUR ENVIRONMENT: THE PRINCIPAL IMPLICATIONS FOR THE INDUSTRIES

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We are all aware of the need for environment protection. The ecological constraint becomes bigger every day and if the will to show consideration for the Rio Agreement in 1992 still exists, our development modes have to change. However, it would be a sheer utopia to think that investors and companies are going to change for ethical reasons only. Authorities have therefore to guide consumers towards less polluting products and make the producers pay for their abuse to nature. Governments have implemented environmental policies with the hope to change people's mentalities, consuming trends and production methods. When dealing with pollution problems, one can observe that incentive systems are in place in Europe and Japan in opposition to the United Nations of America where the command and control approaches is usually applied.

Some economists have theoretically studied the respective characteristics of incentive systems and command and control approaches. Others have analyzed the consequences of these instruments on the basis of concrete examples. Some industries have received special attention: brewing, electric power, paper, chemicals, primary metals.

A synthesized overview of these major and/or interesting studies would be useful. That is the purpose of this paper, although restricted to the implications for these firms.

Many reactions towards these environmental policies are controversial. A lot of people think they are restricting and unproductive. Is it true? What are the effects upon economy and in particular upon the companies? We will try to answer these questions through practical considerations. Unfortunately, very few conclusive studies showing significant results have been made to back those intuitions up.

We first study the various types of company responses to the new constraints imposed by environmental regulations.

In the light of the studies made by some economists, it seems that most of the responses studied and/or given are about:

- "Change in the input mix" means any change initiated by the will to alter the input mix;
- "End-of-pipe technology" means any technology admitting only pollution abatement, without any recovery whatsoever of natural resources/components/energy by the company;
- "End-of-pipe technology with added value" covers any pollutions abatement technology allowing closed-loop operation at least for a part of the natural resources/components/energy;
- "Cleaner technology/product" means any cleaner production technology or any cleaner product compared with the production technology or the company product.

The second part of our study deals with different consequences of ecological instruments listed in literature.

We will first focus on the probable alteration of the companies competitiveness in relation with regulation.

Competitive benefits usually fall into the following two categories: price competitiveness, which consists of gaining a competitive benefit by selling products at the lowest price and structural competitiveness.

Then, seen from this outlook, we will analyze most of the indicators developed in the academic literature; like investment costs, prices, trade balance, localization and delocalization, bankruptcy and unemployment and also more globally growth and productivity. After this, we will be able to appreciate the relevance of these indicators as far as environmental dimension is concerned.

The conclusion shows a summary of various aspects currently studied, the weakness of those surveys and some solutions to avoid them in the future.

To end the paper, we propose some improvements that could be made to study the impacts of environmental instruments upon companies. These are not a list of criticisms about the articles analyzed, but merely an imperfect image showing the problems to which authors were faced in a field where a lot still needs to be achieved. These improvements are ranked according to their relations with data, variables, indicators or models.

TOWARDS INDICATORS OF SUSTAINABLE DEVELOPMENT FOR FIRMS - CONCEPTS AND DEFINITIONS

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Sustainable development is made up of three closely connected issues and each one of these needs to be addressed by industry: (1) environment, implying minimal use of non-renewable resources and minimal emission of pollutants, as well as protection of ecosystems in order to avoid the loss of plant and animal species; (2) equity, which applies not only to relationships between the First and Third Worlds, but also within countries between people, which in turn implies the reduction of unemployment; (3) futurity, which requires that society, businesses and individuals operate on a different time scale than currently operates in the economy, and therefore implies longer term, inter-generational considerations (Welford 1995).

Thus society has to formulate sustainability goals, covering all three aforementioned issues. The extent to which given goals are met can be used to compare similar existing units (products, plants, firms, countries) in terms of their performance with respect to some specific target (economic, environmental, etc.). In this case their utility is to identify

"laggers" among the units considered as well as the causes of lagging, and to adopt relevant corrective actions (in the form of, e.g., taxes or regulations). Conversely, indicators can be used to select the best among a set of possible alternatives still to be implemented.

Sustainability indicators have been developed so far only at the most global level, i.e., the state or country level. Due to their central role in human activities and development, firms should play an important part in the attainment of sustainability goals. The purpose of this paper is therefore to propose some ideas of concepts that may be worth considering in the definition of indicators of sustainable development at the firm level.

The paper begins by enumerating various kinds of information, pertaining to economic, social, and environmental factors, that should be incorporated in the definition of sustainability indicators. Time considerations reflecting the important issue of futurity are included as well by stressing the long term perspective of several factors (product durability, availability of resources for future generations, impact of industrial activities on global warming, acid deposition, ...). The sustainability indicator we are looking for would also incorporate, in an implicit and indirect way, various qualitative aspects (technology, culture, cooperation) which are hardly measurable and therefore do not make part of the variables explicitly accounted for.

We assume that we have observations on the aforementioned factors for a set of (existing or possible) decision making units (DMUs), e.g., firms in an industrial (sub-) sector. For each of the three categories of factors, i.e., economic, social and environmental, we consider factors whose value should be minimized (all other things being equal) and those whose value should be maximized, in the perspective of sustainability.

We consider two classes of indicators, the first based on the framework of cost-benefit analysis, by using cost coefficients reflecting either market prices or shadow prices of the factors, and/or coefficients reflecting priorities defined by public deciders. That indicator can be paralleled with that of Pearce & Atkinson (1992, 1993) developed at the state level. As a second proposal, we generalize the idea of extending the theory of productive efficiency to the consideration of environmental factors. In this scope, we previously showed how various DEA (data envelopment analysis) models could be defined, that highlight different aspects of the problem, i.e., different priorities that can be given to some factors with respect to others. The main advantage of DEA models is that no a priori weight has to be given to the factors taken into account. Three examples of DEA models that consider the sustainability problem under three different perspectives are examined for illustrative purpose.

In this framework, the efficiency of each DMU is computed from the data set using mathematical programming techniques, resulting in DMUs that are "efficient" (or sustainable) and define the sustainability frontier among the set of DMUs, and DMUs that are "inefficient" (or unsustainable). Sustainable here refers either to best practice (when the data set is based on existing DMUs) or to ultimate sustainability goals defined by society (when the data set is based on possible alternatives).

The paper ends with a few comments about the necessary trade off between the number and representativity of characteristics accounted for, which can be solved by some preliminary investigation of the data using e.g. principal component analysis. The latter kind of problems might also find a partial solution if, instead of trying to develop one unique, aggregate sustainability indicator, we define two or three partial indicators that stress different aspects of the problem. For example, we would consider two indicators, one centered on environmental preoccupations, the other stressing social preoccupations. In this way we could gain accurateness in the description of the situation, while providing the public deciders with the possibility of meaningful tradeoffs.

A few last comments are made about the actual use of the indicators. Not only could they be exploited to compare firms of a given industrial (sub)- sector in a national context, but perhaps more importantly in a sustainability perspective, they could serve to compare firms or sectors in different countries (in the First and Third Worlds for example) that can significantly differ in the way they take social and environmental goals into account. This can result in the formulation of adequate corrective actions since the causes of unsustainability can be detected from the indicators. And here we return to the ultimate objective of using indicators, namely, providing the governments with adequate tools to adopt regulations and incentives that will ensure overall sustainability. Before reaching such an ambitious goal, there is a lot of work in front of us, and our hope is that this exploratory, speculative paper will contribute to identify some meaningful suggestions for further research.

SOCIO-ECOLOGICAL INDICATORS FOR THE ENERGY SECTOR OF GOTLAND ISLAND, SWEDEN

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To be able to know whether a society is developing towards sustainability or not one need a definition of the sustainable society and indicators that measure the deviation between the present situation and the sustainable society. In this paper we use four socio-ecological principles as minimum conditions for a sustainable society:

- Substances extracted from the lithosphere must not systematically accumulate in the ecosphere;
- Society-produced substances must not systematically accumulate in the ecosphere;
- The physical conditions for production and diversity within the ecosphere must not be systematically deteriorated;
- The use of resources must be efficient and just with respect to meeting human needs.

Based on these principles we develop socio-ecological indicators that indicate the development toward sustainability. The socio-ecological indicators focus early in the causal chain, e.g., on societal activities rather than on environmental effects. This implies that the socio-ecological indicators can give an early warning signal.

We give some examples of socio-ecological indicators from the energy sector on the island of Gotland in Sweden. The aim is that the indicators will be used in decision-making processes at various levels in the society.

This paper is part of a project in which more socio-ecological indicators for all sectors of the Gotland society will be formulated.

SOCIAL ECONOMIC PROBLEMS OF THE DEVELOPMENT OF PERESLAVL NATIONAL PARK

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Pereslavl National Park (PNP) is a unique territory - 22000 hectares of land, it is not only of natural value, but of cultural-historical value as well. A man settled this area very long ago, ancient places of settlements and funeral fields which are more than 6000 years old are found here.

These lands survived Tatar's yoke, Polish-Lithuanian intervention, abolition of serfdom, the development of trades and first industrial enterprises.

The centre of National Park is Pereslavl-Zalessky, it is situated on the bank of picturesque lake Pleshcheevo. This lake is of ice-age, it is the spring of drinking water. There are 16 species of fish in the lake, among them - the famous tsar's herring.

One of the main tasks of National Park - to keep the existing view of landscape on that stage which is determined for the aims of the park: scientific, demonstrating or recreational.

That's why the special attention nowadays is paid to the elaboration of the plan of the zones of different meaning and to the preparation of the Park's Project.

Some problems have appeared:

1. The creation of informational system of natural, historical and recreational resources;
2. Economical evaluation of biological variety;
3. Regulation of thrifty activity according to the law especially in guarding area;
4. The preparation of skilled workers;
5. Communication with local population.

The Ministry of Nature of Russia included the PNP into the experiment on completing of economical mechanism of nature's using. Nowadays the first stage of the experiment on the working up of the package of normative documents is going to be finished.

The Ministry of Science and technical policy of Russia realize their project on the territory of our Park "Agrotechnopolice - Pereslavski".

The aim of this project - to introduce new ecological dangerousless technologies on the production and working up of agricultural production.

It's important to prepare skilled works as for the National Park and for the enterprises as well.

Under the leadership of National Park the ecological class is forming in our town. At school N9 the pupils have ecological education. This year Pereslavl college opens the new faculty for the students on the speciality "Preservation of the environment and rational using of natural resources".

For strengthening of communication with local population and forming of public opinion the management of our Park publishes the newspaper "Pereslavski Rodniki" and some other printing production.

EMERGY EVALUATION OF THE PRODUCTION OF SUGARCANE, ALCOHOL AND SUGAR AT THE ESTER SUGAR PROCESSING PLANT IN BRAZIL

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The need to offer practical anwers for the sustainable use of natural resources, as a basis for foodstuff, raw materials and energy, is met by a powerful instrument in the quantification of the relationship man/nature: the evaluation by embodied energy, or *eMergy*, spelt with an 'm'. Emergy, or embodied energy, is the initial solar equivalent energy present in any natural, or human induced, process or product, which has passed through the relative energy transformations. It is thus possible to comparatively evaluate human investments and the contributions of natural resources which sustain us.

The production systems of sugarcane, sugar and alcohol, including the component for the agricultural production of sugarcane were evaluated withthe embodied energy approach for the Ester Sugar and Alcohol refinery in Cosmopolis, Brazil. After summing up all inputs in embodied energy, or eMergy, units, the transformities for the sugarcane, sugarcane juice and bagasse, sugar and alcohol produced were calculated. Transformity is the quantity of solar energy equivalents necessary for each joule produced of each product.

The value for the transformity of the produced alcohol, 8.62 E4 sej/J, is close to older estimates for other types of fluids and the transformity of sugar is very similar, 8.97 E4 sej/J, being greater due to the greater energy costs due to processing. The value of transformity for sugarcane juice and bagasse, 4.85 E4, is the same as they are by-products and is similar to that for the extraction of natural gas.

The Yield per Investment Ratio, Y/F, evaluates the efficiency of a specific production process comparing the produced quantity to the inputs used in eMergy terms. This ratio for alcohol and sugar is respectively 0.95 and 0.94, less than unity, which means that these products are not having any effect on the vitality of the economy.

The Environmental Loading Ratios are relatively high, 8.82 for sugarcane, classifying the system as an intensive agroecosystem, 9.42 for the sugarcane juice and bagasse, 9.62 for alcohol and 9.79 for sugar.

The benefits related to sugar sales in the international market, ratio of 1.04, are minimal because this ratio is equal to one. Were the ratio inferior to 1 Brazil would be losing embodied energy to buying nations. Liquid fuels are essential to economic processes such as transportation and the system for the production of alcohol from sugarcane supplies this need with a neutral effect in the eMergy economy of the nation.

EMERGY EVALUATION OF AGRICULTURAL PRODUCTION SYSTEMS TO IDENTIFY RESEARCH PROPOSALS IN AGRO-INDUSTRIAL TECHNOLOGY FOR SUSTAINABLE DEVELOPMENT

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The embodied energy evaluation recognizes and accounts for environmental contributions to human production processes by measuring them in energy equivalent units (solar energy joules), a common indexing measure to these processes. The quantification of these contributions is essential to understand sustainability and plan for it. The need to aggregate value to the final products by an agroindustry more intimately related to ecological processes can find answers by a quantitative evaluation of several alternative production modes and their energy profiles.

The present Brazilian rural socio-economic model, that privileges large extensions of monoculture, mainly for export cash crops, and incentivates intensive use of pesticides and chemical fertilizers with resulting soil degradation, pollution of the water system and rural exodus to the suburban ghettoes, has been recently counterpoised by a number of alternative agricultural models which will be studied in relation to both environment and scaling down of local and regional agroindustry. This study aims to support the fixation of the traditional rural populations in their home environments, the lessening of the environmental impacts of agricultural and agroindustrial activities and the optimization of energy use and of energy flows. It also aims to provide alternative models of agro-industrial production within a conceptual vision of integrated systems in regional land using.

High inputs, or conventional, agriculture will be compared to organic agricultural and farming techniques using eMergy as a meter. Rice, beans, corn, vegetables and dairy production from various organic farms will be evaluated jointly with the associated industrial processing. Energy and eMergy models will be developed to evaluate eMergy economy to scale within these systems.

It is hoped that this study will open new areas in the investigation of the processes that tie man's subsistence with the environment and indicate production patterns better suited to associative economies of small and medium rural producers as well as for larger agricultural enterprises.

MODELLING OF RUSSIAN SOCIO-ECONOMIC DEVELOPMENT IN THE TRANSITIONAL PERIOD AND ITS ECOLOGICAL CONSEQUENCES

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In the paper a system of ecological-economic models for Russia together with information, scenarios and software is considered. The results of computer simulations are analyzed, and a long-term prognosis of the development of the ecological situation in Russia is constructed.

Russia is currently in a state of deep economic, political and structural crisis. This situation is unstable and is a part of transition from centralized governmental regulation of the economy to a market economy. Most dangerous ecological situation in Russia was formed in recent years. Two opposit tendencies have taken place in pollution of environment. The first tendency is decrease of pollutant production by factories and other stationary sources of pollution because of decrease in production output, closure of factories, or structural changes (especially in the military production complex). The reduction of animal husbandry and crop production has led to reduction in environmental pollution as well. The second tendency has the opposite effect. Difficult economic and financial situation in many branches of industry and agriculture has resulted in reduced investments into repairation or construction facilities that pollute less. In some branches of industry, the costs of pollution control facilities make up 1/3 of fixed capital costs and in animal husbandry it can be up to 80%. State financing of research work has been reduced and the rate of technical progress has decreased. All of this results in an increase of pollutant output.

The economy of Russia has stayed for three years in condition of post-shock inflation with a 10-25% rate per month, and suffered a decline of GNP of 19% in 1992, of 12-14% in 1993, and of 16-18% in 1994. Private consumption and investments dropped in half in comparison with 1991. The material assistance to the republics of the former USSR stayed at the same level as in 1992- about 20-22% of Russia's GNP; Capital flight was about 13-15% of GNP. Unemployment is estimated at 12-15% of the labour force. Though the state budget deficit is estimated at 10-20% of GNP, the financial situation with hard currency in 1993 became better. In 1993 there were 21 billion dollars in the accounts of enterprises, 6 billion dollars in the Central Bank; people had 6-8 billion dollars in cash. Export-import balance was 16 billion dollars in 1993 and 20 billion dollars in 1994.

An interactive system for computer modelling, ECORUS, was used for joint analysis of ecological-economic problems, prognostication of development outcomes, and estimation of control efficiency. Computer simulations over the time interval from 1990 until 2010 gave the following results: GNP decreases from 700 billion roubles in 1990 to 540 billion roubles in 1995 and then increases to 760 billion roubles in 2000. Thus the economy shrinks 23% and then regains its earlier level in a 5-year period. The average rate of economic growth after the depression is 5.6%. Essential changes take place in investment policy. During this period the total amount of investments decreases threefold because of reduction of government programs and cessation of direct, centralized state financing. Fixed capital of industry do not decrease; its growth rate decreases from 1992 until 1998, but the average growth rate is 2% per year till 2000. The dynamics of branches of the economy corresponds to the dynamics of GNP at a whole. Thus, all branches of industry experience depression in 1990-1995. The most important decrease of production output is observed in the following branches: construction (over 50%), machinery (30%), construction materials (40%), food (30%), transport & communication (27%).

In the 'pollutants' submodel the output of the aggregated pollutant in the atmosphere (after purification) is calculated. The models describe three main effects: a growth or decrease of pollutants production connected with economic growth or depression; a growth of pollutants output connected with deterioration of pollution control facilities; structural changes to the economy.

Calculations of the model gave the following dynamics. In 1995 (in this year the crisis will cease and economic growth will begin) 14.5 million tons of pollutants are released to the atmosphere. In 2000 that figure is 48.9 million tons. Calculation of the scenarios generated the following changes to the ecological situation in Russia in 2000. Total output of the aggregated pollutant by all branches of economy will not change. With the existing technology for production and purification in 2000, the output of pollutants will be the same as in 1990. Some growth of pollutant production is expected in the branches “electricity”, and “oil-gas”.

If in 1998 the level of economic activity in Russia is restored to the level of 1990, then the ecological situation will become worse. According to one scenario, in 1998 pollution reaches the level of 1990 as well as the economy; according to another scenario this level of pollution is reached in 1996 even though the level of economic activity is relatively low. In 2000 the level of pollution in the first scenario is almost double that of another scenario, -- a result that means aggravation of all ecological problems.

Thus, in the case of the first scenario implementation, the realization of special ecological programs is necessary (legislation, investment control) to stop the tendency of a severe aggravation of ecological problems. Finally, according to this scenario, in 2000 Russia will have an ecological situation at the level of 1990 and in 2010 the level of pollution will be double that of 1990.

The following conclusions based on computer simulations can be drawn. The economic crisis in Russia has stabilized the ecological situation (and air pollution as well) to some extent. This is connected to the reduction of production output. Future development of the ecological situation depends upon economic growth and economic policy. Currently, pollution control facilities are not put into operation and existing ones function inefficiently and deteriorate quickly because of declining investments. If this tendency continues, then even the decreasing amount of pollutants could not be purified by existing pollution control facilities. In case of future economic growth, the situation with purification will be aggravated. Economic crisis gives us time for preparing the basis of state ecological policy. It is important to have budget expenditures on environment protection. Ecological legislation with fines for enterprises exceeding permitted pollution levels should be adopted at the local and state level.

ON THE FORMATION OF THE SOCIOLOGICAL TYPOLOGY OF DISASTERS

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Working out methodological issues of ensuring sociological acceptability of technological and ecological risks confronts difficulties of methodical non-development of the issues of analysis and formation of scenarios of would be interaction of region technosphere with its socio-economical, -political, -cultural atmosphere.

Inadequate relation to these regional safety aspects for a long period of time resulted in arising transformation of components of the substantial risk factors and their public accentuating.

Due to the a.m. factor during last years socio-political and -economical processes acted not only as a strong catalyzer for potential regional technological and realization of natural hazards but they also engendered a new class of risks connected with economic and political instability. These new risks directly affect the natural and technological environment of those regions.

Transforming the physical principle of restrictions into the sphere of human activities such as economics, law, culture, politics, morals etc., leads to the necessity of searching new strategies for conducting analysis of technogenes regularities on the basis of the selforganisational principle, enable to reveal some through structures connecting technosphere with community and nature and explain them as an indivisible mechanism.

Multidisciplinarity of such approach to solution of safety problem will be required, on the whole, when specific knowledge areas formation in the context of heuristic directive lines is expressed in the questions: "What?" <objectivity -"typology">, "Why?" <causality - "functionology">, "How?" and "Who?" <organization -"structurology">, "When?" <time - "chronology">, "Where?" < space - "topology" >.

On thus constructed systematic principle a conceptual scheme of overcoming the evident or latent technogeneses contradiction between extravertal and intravertal human activity, between technical potential growth and the growth of entropy areas of assessment and control of its consequences is based.

The so-called extreme situations, catastrophes, if they could be considered sudden disasters are the logical continuation of

aggravation of this contradiction.

There are two cases of hazardous sources existing in a potentially dangerous situation as well as in a real catastrophic one that should be classified as the primary and the secondary ones having autonomous catastrophic consequences. The manifestation of primary hazardous sources is accompanied by non-controlled component characterizing natural events, such as underground roars, shocks, surface ruptures and collapses and technical one characterizing industrial accidents, such as explosions, fires, construction and communication failures.

The secondary hazardous sources manifest themselves through drawbacks of the social systems culture component expressed in organizational and performing behavior.

One should speak about social factors acting capable to reduce significantly the level of safety and catalyze a real nature disaster or an industrial accident transforming it into a social calamity.

There are many instances which prove social factor action. They are as follows:

- seismostable buildings collapse being admitted to exploitation by lawful final acceptance acts, constructions made of concrete & metals burn as a torch;
- rescuers and doctors cannot help the injured people because of absence of medicine;
- our rescuers arrive at the accident place much later than foreign ones through existing organizational barriers etc.

All this takes place in one or another case because of the social factor action.

The closest task of this range of problems is the formation of sociological typology of natural and technological risk of disasters based on the analysis of social factors qualitative characteristics.

- “Knowledge boundaries” means impossibility to foresee a disastrous events or control them on a modern level of scientific knowledge and technique means.
- “Dysfunction in economics, politics and culture” means instability of economic and political development under condition of manifested ideological aims and absence of distinct normative and legal control.
- “Errors” means probable deviations and mistakes in assessment of situation, perspectives, means of achieving goals and in estimations.
- “Crimes” means deliberate causing substantial damage to the society, some groups of population, terror acts, diversions taking out of effect vital engineering and technical systems.

Methodological principles of formatting the a.m. typology are based on the dialectics of conception such as the "can't be foreseen " and the "unforeseen". The borders between these concepts are movable as foresight has always limits. On the one hand, its boundary is set by the objective cognitive capabilities of any socio-technical systems and, on the other hand, by the socio-cultural context of their functioning.

The logical continuation of the sociological typology of disasters should be considered in the context of developing and reasoning methodical and instrumental framework of the "weighing factors" procedure, level effect determination of public & political and socio-cultural factors for regional safety which makes the basis for computer modelling various scenarios simulating the interaction of the regional technosphere with the community and forecasting its practical manifestations.

SUSTAINABLE DEVELOPMENT (SD) INDICATORS: A CONSERVATION ACCOUNTING APPROACH

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Robust SD Indicators must be anchored on a thorough understanding of the nature of variance and invariance of ecological, cultural, and economic capital. Without this knowledge the amount of resources that can be consumed (depleted) in any one period and conversely, the amount to be conserved, is indeterminate. Thus, the variance/invariance principles must be identified and monitored in order to know if one is on, or deviating from, a SD path. This paper explores some aspects of SD indicators from this perspective and its application to "conservation accounting" underpinned by the assumptions that: (a) the future capacity to produce goods and services is already entailed by the existing quantity and quality of ecological, cultural and economic capital stock, (i.e., initial conditions of the system), (b) invariance can be defined as conserved symmetries among stocks, (i.e., assets and liabilities) and, (c) variances are asymmetric properties that can be defined in terms of flows among stocks, (i.e., credits and debits). The clue to properly identifying SD indicators can be found in: (a) processes entailed by the first and second law of thermodynamics, (i.e., limits to growth), (b) diagnostic indicators of ecosystem health (e.g., biodiversity), (c) technological and ethical constraints entailed by cultural/community values, and (d) social policies (including financial arrangements) entailed by peace, prosperity and the conservation of the planet's

natural resources. While the formal definition of symmetry is a mathematical function that remains unchanged in a set of transformations the concept can be readily translated into accounting principles. The challenge to science is to identify the invariance (or conservation) principles in bio-physical transformations and to make compatible (and integrate) observations of production, consumption and capital accumulation, (i.e., socio-economic statistics). While the paper merely suggests guidelines for future research in Ecological Economics, its particular appeal lies in its potential to simplify the complexity of space/time transformations within the framework of a conservation accounting system. Currently SD indicators are an ad hoc selection of data points based on poorly defined concepts of the margin between human consumption and "environmental carrying capacity". It is maintained here that this approach not only provides a more robust conceptual framework for SD indicators, but can be anchored in the new sciences of complexity and the Funtowicz-Ravetz methodologies of Post-Normal Science.

DEVELOPMENT OF ECOLOGICAL EDUCATION INFRASTRUCTURE IN THE PERESLAVL-ZALESSKY REGION

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Pereslavl-Zalessky is one of the ancient cities of central Russia. It is the southernmost town of the Yaroslavl region and belongs to the Golden Ring of the historical cities of Russia. Pereslavl-Zalessky region is rich in historical monuments and natural resources, and a large part of it forms the State Park of Natural and Architecture.

Several educational centers are using these resources in ecological education:

1. The National Park

   The National Park carries out a broad pedagogical activity, aimed at ecological and humanistic education: distribution of textbooks of methods, filling up databases of architectural monuments and flora and fauna, developing expert systems for environment monitoring.

2. The International Children's Computer Camp

   The International Children's Computer Camp was founded on the northern bank of Pleshcheevo Lake, 8 kilometers from Pereslavl-Zalessky. Every Summer more than five hundred children ages 7 to 17 have summer fun and summer classes. Children are involved in carrying out ecological and biological educational projects.

3. University of Pereslavl.

   In the University of Pereslavl a range of media has been used to deliver ecological materials to students. The idea of creation of a scientific and educational network in Pereslavl-Zalessky is being implemented since 1990. During 1994 the telecommunication system has been significantly improved. The network has been connected to the Internet with a leased line.

On the basis of this network it is possible:

- to organize join projects for all organizations that are interested in ecological education (such projects with prompt information exchange exist now between research groups located in Pereslavl, Tutaev, and Uglitch).
- to build special ecological regional file-server that can be used as a domain in the ecological network, or as a first domain in the small-towns network.

THE DYNAMICS OF THE ECONOMICAL CONDITION OF INDIVIDUALS

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The article aims to present a method of description of the economical condition of individual (person, firm, enterprise, etc.). The economical condition is characterized by N-dimensional (N - number of types of goods) property state vector q: q_i - volume of i-type property which belong to individual (if property is borrowed q_i can be negative). Three kinds of property are distinguished: money, means of production and produce.

The economical condition change is a result of economical processes. Most important processes, such as production, trade, investment, physical depreciation, nonproductional consumption, lease, and tax payment have been taken in consideration. The possible productions are defined by implements which are available. Every type of production has special pattern of mean of production, so we can describe scientific progress as a modification of pattern.

The number of individuals is arbitrary. All individuals, which not considered separately, are united in specific individual - "other world".

The economical processes influence on the economical situation and prices are accounted by linear "demand-supply" price formation model.

This method is applied to economical optimization problems: maximization of the profit (minimum consumption is defined) and maximization of consumption for different time intervals.

RELEVANCE OF BIOPHYSICAL CONSTRAINTS IN SOCIO-ECONOMIC PROCESSES OF SELF-ORGANIZATION

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We describe the process of self-organization of a socio-economic system as generated by the resonance between human activity that stabilizes processes of energy degradation, and processes of energy degradation that stabilize human activity. This autocatalytic loop is described in terms of biophysical observations that enable us to assess the stability basin of the system. We provide two examples: the first considering pre-industrial societies in which the biophysical parameters that describe the system can be adequately described; the second example considering modern economies able to expand their scale of operation by relying on flows of credit and commodities.

This type of analysis establishes a link between i) the parameters affecting the standards of living (labor charge, dependency ratio, level of services, level of consumption per capita), ii) availability of natural capital (natural resource required as inputs of economic processes and natural processes required as life support system), and iii) performance of technology.

REGIONAL APPROACH TO SUSTAINABLE DEVELOPMENT PROBLEMS: KHILOK RIVER WATERSHED MANAGEMENT PROJECT

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The peculiarities of the Model of Sustainable Development for the periphery of the Lake Baikal watershed and Upper Amur, for Central and Eastern Zabajkalie are reviewed in the report. A methodology had been worked out and on its basis a draft of Management of Natural Resources of the watershed of river Khilok has been done. This work was done in the frame of preparation of the project for improvement of natural resources management and biodiversity conservation of the Lake Baikal watershed under World Bank support.

Khilok watershed is a river ecosystem on which an economic activity of the Chita region of Lake Baikal watershed is based, and it can be proposed as a model area. The basis of the project in NRM in the Khilok watershed should become the

implementation of a number of sub-projects, which will ensure gradual but drastic change of the existing practice of management of this territory. They are:

- functional zoning of territories;
- development of the existing system of monitoring the conditions of environment;
- estimation of ecological capacity of the territory and self-treatment ability of Khilok river;
- conservation of a forest as an environment forming factor;
- geo-informational system (GIS) and decisions support system (DSS);
- establishment of informational-consultative service to optimize management on natural resources of the watershed;
- participation of non-governmental organizations and local population in the project implementation;
- transformation of the existing system of management of natural resources of the watershed.

The last sub-project is the key one from the point of view of institutional transformations.

To realize watershed principle of management in full it is necessary to transform the existing nature protecting and control services (land, water, fish inspection, hunting inspection, ecological committee), so they form a service through which local administration can manage the territory efficiently and comprehensively. It is proposed to call this service "Department of Khilok river". The Department is a territory ecological committee, but it has more expanded functions. The establishment Group of Scientific Support of the Department will be one of the most important steps in the process of project implementation. This group will be " an organ of self-consciousness" of the Department and will ensure the working out of strategy and tactics of its work in accordance with stated conception.

Conception of sustainable development which is rather popular today among professional ecologists, economists just begin to find reflection in the process of working out of mechanisms of management of natural resources (MNR). This Khilok watershed management project is one of the first attempts of such character.

One of the most important goals of the project is the establishment of "bridges" between scientific ideas (about sustainable development, "ecologization of economy" and conservation of biodiversity) and real processes of nature use. Though the problem of providing the sustainability can hardly be solved as a result of project implementation, but there is a hope that the effects, which it is possible to consider as "NECESSARY ELEMENTS OF SUSTAINABLE DEVELOPMENT" will begin to work:

- limitation of development by frames of ecological capacity of the territory;
- orientation on ecological-economic priorities including renewable natural resources;
- participation of inhabitants in the process of decision making - it makes additional guarantees of unbiased control;
- two ways connection in the MNR will provide the ability of self-regulation;
- mechanisms will be rather flexible to work and "to reconstruct" themselves (if possible) in accordance information about the results of the decisions taken before;
- institutional mechanism, providing the implementation of system of zoning for defined territory (i.e. the implementation of "system of permissions" on the basis of agreements with land users) will be not only a mean of realization of ecological-economic priorities, but also a preventive measure for protection of land from non-proper use;
- orientation on conservation of environment forming factors as the main condition of biodiversity preservation;
- ecological education, training which exist as local initiatives can get efficient informational and methodical support in the framework of project.

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AN INTELLIGENT SUPPORT SYSTEM FOR MATHEMATICAL MODELING OF ECONOMY[1]

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The intelligent system for supporting the mathematical modeling of economy is designed to help at every stage of working with the mathematical models of evolving economy system analysis:

- creating the new model using foregoing experience on working with the early formed models;
- information filling of the model and identifying its parameters;
- analyzing the model;
- verifying the model, and computing results interpretation.

Our colleagues from the "Mathematical modeling of economical systems" department of Russian Academy of Sciences' Computing Centre accumulate the more than twenty years experience of mathematical modeling of economy. They call their approach "system analysis of evolving economy"[1,2]. As a result of our work in cooperation, the *canonical form for representing the evolving economy system analysis' mathematical models*[3] was produced.

This canonical form allows the experts in the field of mathematical modeling of economy to produce a lot of such models which will be unified by the constraints of the canonical form. Due to this unification the modeller will get the opportunity to find the similar parts in other models for using during dealing with the current model.

The idea of the intelligent support system is based on applying the canonical form as a source for the knowledge and data representation in the economy modeling field.

The first version of the system, which was founded on the earlier image of the domain, consists of two main parts. First one, the knowledge acquisition tool, is oriented on eliciting the notion system of the economical system being investigated. The notion system consists of the set of economical agents and of the set of the relations on agents. Each agent has it's own name, identifier and a set of material or financial actives. The relation may be chosen from one of the set of prototypes and then adopted according to the description of agent and a real consistence of the relationship. The system includes a redactor for creating new and manipulating the present prototypes of relations. Relations may be unary, binary or more high level. As a result of the notion system creating, the intelligent computer system synthesizes the set of differential equations correspondent to the described economical system.

The second part of the system deals with the system of differential equations. It supports the storing of substitutions and identifying the new variables. Different types of standard substitutions are presented.

The next version of the intelligent support system is designing as the number of different oriented tools. First, as described above, will be the system for creating the "rough" model of the domain. The new approach codes new representation of the relations between agents by using new objects. There'll be two ways to produce the new model in accordance to the canonical form: from the notion system to the system of differential equations, and from the "paper printed" mathematical model to the classified notion system with the differential equations. Several types of viewpoints on the designing mathematical model of economy will be presented. The system will allow user to find the appropriate part of the model in the library of previously created models. The wide range of agent's behaviour restrictions will be presented. The next tool will deal with the "rough" model created by the first system. It will support in interactive regime to make the model ready for calculating or to investigate theoretically. The last one is designing to support the interpretation of the results of calculating, storing the results and the commentaries together with the model.

All the tools described are oriented on the experts in the area of mathematical modeling. We plan to design the tools for the end users - people who are interested in using sets of models created as described above. These tools will consist of an expert system interface to mathematical models, calculating mechanism and the third expert tool reduced in accordance to the end user requirements.

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ABOUT EXTENSION OF STANDARD SYSTEM OF UN NATIONAL ACCOUNTS FOR

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REFLECTION OF PRINCIPLES AND PROBLEMS OF SUSTAINABLE DEVELOPMENT

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Standard SNA (version 1968, 1993 [1]) was developed for purpose of measurement and comparative representation of state of economy and economic activity of various countries on various levels. At present, it is realized, that, despite huge significance of existence and wide international recognition of such tool it has a number of defects, in particular:

- The partial representation of whole real range of kinds of economic activity (ignoring household activity and shadow economy).
- Comparatively large temporary periods between real economic events and their information display.

At consideration of problems and principles of sustainable development it is necessary to take into account considerably environmental and social components, information on which in standard SNA, is quite insufficient. More precisely:

- Absence of representation of natural and social subsystems of united socio-ecological-economical system;
- The emphasis on Gross Product (National (GNP) or Internal (GDP)) while the negative effects of economic activity can be found only for a set of industries;
- Orientation of standard SNA on tasks and procedures of analyses, in definite sense, conventional, formed during decades, while in connection with problems of sustainable development is coming to create much more wide and common set of tasks and procedures of analysis.

Many efforts for elimination of the 3-rd from mentioned defects was applied, that was reflected in last SNA UN version 1993 in special Guide on National Accounting: Integrated Ecological and Economic Accounts.

Last SNA version (1993) is an expansion of previous version (1968) by addition of so called satellite Natural Resources Accounts (NRA), on the one hand, and social - on the other. There is a series of examples of practical use of NRA, however they are not accepted everywhere, mainly, because of disputable set of environmental parameters. The examples of application of social accounts from literature are unknown, offered set of social parameters is presented even more disputable one.

The conceptual base of existing standard SNA is based on known Leontief's "input-output" model. Mentioned SNA expansion can be considered as based on appropriate extensions of Leontief's model. However, in definite sense they appear partially to cover new information requirements, necessary for analysis and decision making based on problems of sustainable development.

Therefore, it is reasonable to offer a general conceptual model, which reflects all aspects of concept of sustainable development, and to use it as the base for suitable extension of SNA, as well as for development of new algorithms and procedures, ensuring effective use of information, accumulated in extended SNA. The probable version of such model is caused in this report.

The present experience of realization and appendices of its predecessors had predicted a series of particular steps necessary for realization of model, from which the following are executed at present:

- theoretical bases of new approaches are developed;
- hierarchical set of parameters of state of subsystem of environmental and natural resources is developed;
- similar set for social subsystem is developed.

In near future it is assumed to continue the research on following themes:

- development of interactive procedure (under management on the part of computer program) formation of tables of parameters of main conceptual model (similar improved tables of accounts), from primary information;
- creation of general information system, ensuring storage, maintenance and extension of tables of parameters with uses as regular statistical flows of information, as complex of selective research;
- development of practical computer algorithms of effective use of information, in particular, algorithms of search of optimal strategy of sustainable development on various levels: global, regional, national, and local.

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SCIENTIFIC HERITAGE OF K.G. GOFMAN. ENVIRONMENTAL AND RESOURCE ECONOMICS IN RUSSIA: FROM THE PAST TOWARD THE PRESENT AND FUTURE

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In the end of 1994 an outstanding Russian environmental economist K.G.Gofman passed away. His scientific works in a relatively new branch of science, environmental conservation, one of the founders of which he was, have already become the property of the modern history of the economic thought in Russia. His published works on urgent problems of economics exceed 120 items. During the last 25 years his research had concentrated on theoretical and methodological problems of economic efficiency of environmental protection and reproduction of the natural resource potential, creation of economic regulation systems for environmentally sustainable economic development. The approaches proposed by K.G.Gofman in the 1970s to determin pollution charges and also charges for exploitation of natural resources had been adopted for practical development of a new natural conservation charge system in the Russian Federation within the transition period. Within a short historical period he:

had made a substantial contribution to development of the theory and practice of economic assessments of natural resources and conditions of the environment;

had formulated and substantiated categories of economic and social optimum of environmental quality, of economic evaluation of the environmental assimilation potential;

had developed effective patterns of interaction between economic regulators in coordinating the production and environmental protection processes;

had proposed new approaches to planning and forecasting in environmental conservation, to economic substantiation of a system of environmental quality norms and to perfection of environmental legislation from the economic viewpoint;

had formulated essential theoretical and practical approaches to determining pollution charges and to creating the system of environmental funds, to determining nature exploitation charges in the form of payment for the right to use and of payment for reproduction of the natural resources;

had formulated requirements with regard to taking into account the environmental factor by privatization;

had developed approaches to creating a world unique system of environmental insurance.

Last years his efforts had been directed toward resolving the most urgent modern problem of environmentalization of taxation with proposals on radical change of the general taxation system in Russia, including possible ways of stepwise implementation of those proposals, and also toward substantiating the necessity of introducing the environmental debt category in macroeconomic characteristics of environmentally sustainable development.

These results do not encompass the overal scientific heritage of K.G.Gofman, but even the mentioned theoretical and practical developments, accomplished by him, characterize his outstanding scientific contribution in the field of environmental and resource economics.

EXPERIENCE WITH AND CHALLENGES FOR THE QUANTIFICATION OF PHYSICAL-ECONOMIC PARAMETERS WITHIN THE ENVIRONMENTAL INFORMATION AND PLANNING MODEL (RIM+)

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On request of the Dutch minister of Housing Physical Planning and Environment, the National Institute of Public Health and Environmental Protection (RIVM) will publish, every four years, an Environmental Outlook. This Environmental Outlook has and will be constructed in cooperation with the Central Planning Bureau (CPB), the Netherlands Energy Research Foundation (ECN), the Transport Research Centre (AVV), the Agricultural Economics Research Institute (LEI-DLO) and the National Institute for Water Management and Waste Water Treatment (RIZA). An Environmental Outlook provides information on social developments, use of resources, environmental pressures, abiotic environmental quality, effects of ecosystems, and socio-economic effects of environmental policy. This information is yield from a chain of models. Based on an economic outlook, performed by the CPB, the RIVM models estimate the corresponding environmental pressure, diffusion, deposition and environmental impact.

This paper will focus on one the models from this chain; the Environmental Information and Planning Model (RIM+). The RIM+ computes the environmental pressure caused by economic activities and the effects of measures initiated by environmental policy. The input of this model is an economic scenario, the output is information on emissions to air, soil and water, waste production and energy demand. This model, therefore, translates economic data (from economic scenario's), with the use of technical descriptions of activities, into environmental data in terms of emissions of a certain substance. The output of the model becomes, subsequently, the input for diffusion and deposition models. In the RIM+ economic data are linked to technical data at three different manners. The paper deals with the quantification of the related variables and parameters. However, this can only be done after a short elucidation of the structure of RIM+.

The RIM+ contains a description of Dutch major anthropogenic emissions, waste production and energy demand. These sources, or economic (human) activities, are called processes. The production of aluminum is an example of a process. And so are motorvehicle-repair and paint-use by consumers. Each process has an explanatory variable (EV) which denotes the unity and volume of the process. For instance tonnage aluminum per year, the size of the motor vehicle fleet or tonnage paint products sold per year. A process has one or more emission factors (or waste or energy demand factors) which denote the amount of emissions caused by the activity per process-unity (e.g. kilogram sulfur-dioxide per tonnage aluminum production).

Using the CPB-scenario's future values for the EV are estimated. This is the first link between economic data and technical data.

Emission factors (and waste- and energy demand factors) can be altered by technical measures. A measure is assigned to a process and affects one or more factors of that process. The penetration of a measure can change over time. A penetration of 100% means that the change of a factor applies to 100% of the process. A penetration of 30% means that the new factor applies to only 30% of the process and the old factor still applies to 70% of the process. Economic factors have an important influence on the grade of penetration. The penetration of energy-saving measures, for instance, depends on energy prices. The parameter which denotes the penetration of a measure is the second link between economic data and technical data.

In most cases it will cost something (investments or extra operational costs) to take a measure. These costs are also included into the model. This is the third link between economic data and technical data.

The model representations of both links are quite simple. Quantifying these links is, however, not that simple. It proves to be complicated to choose a scale of detail for which both the required economic data and required technical data are available. The paper will analyze several causes of this problem. Moreover it will discuss how we tackled this problem for quantifying these links in RIM+. This paper, hereby, intends to be a contribution to a, hopefully fruitful, discussion on the challenges to them who want to put ecological economic models into practice.

ECOSYSTEM PROTECTION AND JOINT IMPLEMENTATION OF SULFUR EMISSIONS IN EUROPE

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Joint implementation of emission ceilings is an important topic in the negotiations on a second sulfur protocol in Europe, signed in June 1994. This new protocol explicitly takes the sustainability of ecosystems as starting point. Levels of acidifying sulfur deposition have to be cut such that levels of deposition do not exceed the critical loads: levels of deposition below which no damage is expected to occur. This effect based approach is combined with a precautionary one, using best available technology not entailing excessive costs.

This paper now examines to what extent the joint implementation of national emission ceilings might improve cost-efficiency without jeopardizing ecosystem protection. For this purpose different types of joint implementation are modelled: single zone, with deposition constraints and effects-based exchange rates. The performance of these schemes is assessed under different circumstances: without constraint, in conjunction with regulatory constraints, transaction costs, trading sequence and without non-signatories trading. Calculations are made using the RAINS (Regional Acidification Information and Simulation) model covering 38 regions in Europe. The results suggest that joint implementation in one single European zone may not be politically acceptable since to many countries would be confronted with losses in ecosystem protection in spite of the fact that this scheme generates the highest cost savings.

Furthermore, joint implementation subject to deposition constraints reduces ecosystem protection in only one country. Joint implementation on the basis of cost-minimum exchange rates does not have significant impacts on overall levels of ecosystem protection, saves more costs than deposition constraint trading. It, however, leads to small decreases in ecosystem protection in some countries without reducing their costs. Joint implementation with constant-average-deposition rates ensures that every country is at least as well off as under the protocol; limited cost savings are combined with improvements in ecosystem protection. In conclusion, it appear to be possible to design several rules for the joint implementation of sulfur emission reduction commitments in Europe that allow cost savings while meeting the environmental objectives of the Protocol.

SUSTAINABLE DEVELOPMENT UNDER THE CONSTRAINTS OF SYSTEM DYNAMICS AND INFORMATION TRANSFER

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The idea behind Sustainable Development is the harmonization between constraints of ecological processes and human necessities as a basis for a long term stabilization of environmental conditions. The possibilities of realization of this idea were investigated with a hierarchical concept of the ecosystem. The concept is based on the elementary characteristics of ecosystem elements. In this way six analytical subsystems (geological, hydrological, atmospherical, microbiological, botanical and zoological) are defined which are contributing partially to ecosystem functions. Each of these subsystems has its specific characteristics in dimensions and dynamics of energy, structure and information. Considering spatial distributions of the subsystems ecosystems can be defined in a synthesis as a global filtering layer which is influencing reaction processes between substances. But its functionality is determined by local factors in interdependency with factors of larger scale.

With this concept the environmental impacts of human activities by activating new substance processes and by land use can be described. These impacts are influencing natural processes with large differences in dynamics and quantities. Actually we have to accept, that human knowledge about future development of these processes is very restricted. Because of these constraints measures for the realization of sustainability have to include environmental information and concepts of adaptability in the socio-economic system.

Because of the multidimensionality of environmental processes it is necessary to use information systems with hierarchical organization. Environmental processes with little changes in space and time (e.g. geological processes) are dominating over processes with faster changes in space and time. Dynamic properties of environmental processes are also important for the optimization of measuring expenditures. Processes with low dynamic can be observed with large time lags between singular observations but with high spatial resolution. With increasing dynamic characteristics time lags have to be reduced to the

debit of spatial resolution.

A specific problem is the transformation of these informations to the socio-economic system because of the different temporal perspectives of each information. In general there are very few institutions in the socio-economic systems which can realize strategies for more than hundred years, which is a relatively short time scale for environmental processes. Most of socio-economics institutions are handling strategies within time scales between one to ten years. On the other hand human impacts (e.g. buildings, land reclamation) can last more than hundred years.

But there are also differences in the dimensions of spatial resolutions of environmental observations. Federal governments should have an overview over the country as a whole, regional governments over regions and private actors over their area of responsibility. But all informations should be nested in the information set of the larger scale. This problem of fractality in information and responsibility needs an adequate concept for realization.

We use for these purposes the so called "fjord concept", because of its similarity to the situation of a coast with deep fjords. In this case a general overview and the development of general measures for the coast have to follow the general coast line and not the structure of each individual fjord.

This is the same problem which government have to solve in environmental tasks. It has to oberve the mainstreams of environmental processes in the country and have to use informations about global processes. These informations must translated into the socio-economic codes (e.g. fiscal regulations) for regional authorities and for individuals. Such constraints have to be flexible enough that local peculiarities can be linked with it. To speak in the coast example, regulation have to be flexible enough that in the case of a north-south coastline measures can also be adequate in an east-west fjord. Regional authorities and individuals will be oritented on the situation of their neighbourhood and will also adapt measures to these factors. Translated to the example nobody will navigate a ship in the east-west fjord to north or to south if he wants arrive the next fjord, but he needs some informations about the situation at the open sea. In a similar way environmental measures of regional authorities and of individuals have to be developed and assesed. Time scale is included in this concept in such a way, that short processes are considered in local measures and long term processes are considered in governmental or supranational measures.

THE "ECOPOLICE"-CENTRE SYSTEM - A VITAL SUSTAINABLE EDUCATIONAL SYSTEM AND LINK AMONG PARENTS, STUDENTS AND TEACHERS IN HIGH INDUSTRIAL URAL SYSTEMS

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Each fall parents within the Novouralsk communities (small "closed" town near Ekaterinburg) send their children to one of the finest educational centre "Ecopolice: culture, education". The journey is not especially long, but the experience is profound, in many ways a whole new of life for the next 15 years. What can students and their parents expect over the next 15 years at environmental educational centre "Ecopolice"? With several environmental and economical courses, a network of student services and 60 activities, they can expect "Ecopolice" to offer many outstanding opportunities. Beneath these curricular and extracurricular dynamics exist an important safety net - the biosocial adaptation and environmental education centre - which is a conscious effort to work with each student in daily one-on-one situations.

The main aspects for environmental education programs in the "Ecopolice" are:

- economic structure (what changes are needed to solve environmental problems?);
- politics (do we need economic growth to pay for the solutions?);
- social backgrounds (the way we live affects the environment);
- estrangement (we lost contact with nature);
- responsibility, attitude, behavior;
- ethical, theological, vital questions;
- co-operation and support.

Developed in 1990 as one of the first anti-nuclear environmental education programs, the "Ecopolice" system is recognized regionally for its excellence. It is based on the belief that each of the students can improve their environment and the economic sphere of life. The classroom teachers, who see students daily, can be the best counselors in sustainable development of the socio-ecological and economical system of Ural.

Center "Ecopolice" is very important in Ural industrial region. In an increasingly interdependent world our decisions and actions as consumers and producers influence the way in which the environment is used and managed. These restrict our ability to make the changes that could remedy environmental problems. If we are to resolve environmental concerns we must address the needs, concerns and fears of those who suffer from environmental degradation, and of those who see

comfort or authority begin threatened or undetermined by changes to environmental management.

In varying degrees, these are the things that "educate" us throughout our lives. These are the things that make us the people we are and determine the way we view and use the environment. If environmental concerns are to be resolved, all these different aspects of education need to take on responsibility for improving the quality of decision making about environmental use and interaction.

One of the prime functions of education is to prepare people for the opportunities, responsibilities and experiences of their lives.

Some of the most telling responsibilities relates to the way we use or influence the use of the environment. Therefore, if education is to fulfill its complete social role it must prepare people for their role as environmental decision makers.

For these reasons everybody needs to be given and has a right to receive an environmental component to the overall education entitlement that they receive through their lives:

- an entitlement of experiences which will enable to understand, analyze and respond to the various environment situations and issues that they meet within their day to day living;
- an entitlement that empowers the individual to have a well informed and therefore confident and effective voice in the decisions that will determine the structure and quality of the places where they live and work;
- an entitlement that provides new or revived skills that enable the individual to benefit from these decisions;
- in total an entitlement that enables participation through understanding and insight, and that encourages committed participation through personal relevance and personal benefit.

COMPETITION BETWEEN TECHNOSPHERE AND BIOSPHERE: TEMPORARY COEXISTENCE OR COEVOLUTION?

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One hand, we can say that technology has permitted a progressive emancipation of Man from Nature. On the other hand, the economics and technological growths more and more energy demanding, natural resources demanding and space demanding. These two dynamics imply that the Technosphere and the Biosphere appear today as competing systems. Vitousek et al. [1986], for example, estimated that while only about 40 percent of terrestrial net primary production is used directly and indirectly by humans. with current rates of growth population and energy consumptions going on, 805 of the annual net primary production should be used by humankind by 2030.

The stake of sustainability forces us to think about the long term of technological and economic development. There is now a large agreement upon the necessity of setting up sustainable development,. But, there are various approaches of this issue. Many contradictory hypothesis are facing concerning the evolution of the relationship between the Technosphere and the Biosphere. Though central in the sustainable issue, these hypothesis are not often clearly explicited by the authors. We think that this situation implies a certain confusion in most of discourses upon sustainability. Even, in many cases, some contradictorily hypothesis coexist in the same presentation. Furthermore, we would be able to show that some theoretical analysis, apparently in opposition are not so far from each other; or, in the reverse, theories similar at first are not so close.

The first aim of our proposal is to define a topology of the different paradigms and hypothesis related to the issue of the competition between the Technosphere and the Biosphere.

1. The first paradigm is what we call "temporary coexistence" that is to say, if the two systems can have both a development during a period of time, the conclusion of their competition corresponds necessarily to the separation of the two developments. The first possibility is the recognition of the supremacy of only one system. Two; cases can be considered:

    1.1 The final supremacy of the Technosphere is the first hypothesis proposed concerning the relation between the Technosphere and the Biosphere. This means that the Technosphere should take in charge all the needed life-support regulations. An "ecologist" version of the hypothesis is the "Biosphere-2" project, a sort of second

"Noah's Ark", located in Space Ranch (Arizona), where scientists try to rebuilt Life-conditions in an artificial environment (Allen [1991]). An "economist" version of this hypothesis is given by the neo-classical theory, Neo-classical economists (Toman [1994]) declare that, with a competition price system, substitution between factors of production and technical progress can maintain the productivity of the economic system in the long term. In this case, the decreasing of the stock of "natural capital" finds a compensation in the increasing of "man-made capital".

1.2 The recognition of the final supremacy of the Biosphere is the symmetric case of the "temporary coexistence" paradigm. This scenario of the Technosphere's collapsing is shocking, especially for economists, as Georgescu-Roegen [1975] pointed it. We can find this hypothesis in the ecologist literature, where a biocentric point of view is generally adopted. One of the best examples of this hypothesis of the final supremacy of the Biosphere can be found in Lovelock's writings and his Gaia Hypothesis (Lovelock [1991]).

1.3 A third possibility in the "temporary coexistence" paradigm is a "complete disaster" hypothesis, which corresponds to the collapsing of the two systems in competition.

An illustration of this "meta-catastrophic" scenario can be found in The limits to Growth Report (Meadows et al. [1972])

2. The econd paradigm is called "coevolution". The science of ecology (Ehrlich, Raven [1964]) is the original field of this notion: coevolution involves reciprocal natural selection between two or more groups of organisms with close ecological relationships but without exchange of genetic information between the groups (without interbreeding). In reference to the "ecological economics" movement (see Gowdy [1994])) try to consider at the same time the development of the two systems: the Technosphere modifies irrevocably the Biosphere and, in return, this one modifies the Technosphere. We can show that there are several versions of this coevolution paradigm. A first one is "naturalistic". A second one is "technocratic", and can be illustrated by the "spaceship Earth" vision proposed by Kenneth Boulding [1066]. A third one - that we can call "culturalist"-underlines the need for a pluralistic and "multi-cultural" answer to the sustainability issue. This point of view is illustrated by the work of Jammes Swaney [1987] and Richard Norgaard [1981, 1991, 1994].

The second aim of our proposal is to clarify the theoretical consequences and the political prescriptions associated to these different hypothesis. From a geological perspective, human evolution appears like a tremendous evolutive acceleration. The question is to point out if we face a "temporary coexistence" process or "coevolution" process. Considering the characteristics of "arithmomorphism" (Georgescu-Roegen [1971]), the problem is that it is impossible to really measure an evolutionary process, A third aim of our proposal is to measure the competition process between Technosphere and Biosphere by striking several balances; material-balances, energy-balances and space-balances.

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REGENERATING THE COMMONS BY BUILDING INSTITUTIONS LESSONS FROM TWO CASES IN RURAL INDIA

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The increasing pressure of a growing population on (tropical) forests, pastoral grazing lands, water sources, and other commons has arisen as a major subject of concern. There is a need to move away from the deteriorating state of open access towards a more regulated state of common property resources. This has given rise to the study of village level institutions, which focus on collective action and peoples' participation, involving the weakest sections of the society. This is a process of institutionalization which can start from within the community by changing informal rules like norms, values and traditions. This can be further supported by the government by changing formal regulations like laws, constitution and property rights. However, the success of institutionalization depends crucially on the amount of participation of the members of the community.

This paper uses both cross-section and time-series data from two distinct cases in rural India, to describe this process of institutionalization. Thereupon, a model will be estimated, to derive the amount of correlation between the incentive to participate and the aggregate of the quality and quantity of resources in the common. This estimated model will form a basis for simulation to derive the effects of changes in the model parameters.

EMPLOYMENT AND ENVIRONMENT: THE TRADE-OFFS IN AN ECONOMY IN TRANSITION

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One of the most pressing problems in an economy in transition is that of unemployment, as the structure of production changes. Hitherto, the 'costs' of this unemployment have either focused on the value of the lost production, or on the costs to the government of supporting the unemployed. From a social welfare viewpoint this is inappropriate. In this paper I discuss the costs of unemployment in terms of their impacts on human welfare, particularly the health effects.

On the positive side, as inefficient industries are shut down and as production responds to market pressures, wasteful government subsidies are reduced, as is the level of environmental pollution. Clearly therefore, there is a trade-off between the environmental and economic efficiency benefits on the one side, and the welfare costs of the unemployment.

In this paper a simple model is developed to analyze this trade-off. A single firm has a short run production function in which output is dependent on the level of labor input. The present position is characterized by 'inefficiency' in that the firm is making a loss and overproduction is taking place. Environmental damage is a function of the level of output. The efficient production point is known, as are the efficiency prices.

The problem to be solved is to minimize the costs of moving to the efficient point. The paper characterizes the efficient dynamic path, and gives some illustrations of such a path for the coal sector in Russia, for given values of: the efficiency losses, the environmental costs of using coal, and the costs of unemployment.

SENSITIVITY ANALYSIS OF LINEAR ECOLOGICAL-ECONOMIC SYSTEMS

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The article concerns the symbolic technique for the sensitivity functions calculation of linear systems

$$X = AY$$

where X is $1 \times n$ vector, Y is $1 \times m$ vector and A is $n \times m$ matrix. For this purpose Δ_A and the δ_Y -vectors are introduced.

The Δ - matrix with respect to the element a_{ij} is the matrix of derivatives:

$$\Delta = \begin{bmatrix} \frac{\partial a_{11}}{\partial a_{ij}} & \cdots & \frac{\partial a_{1m}}{\partial a_{ij}} \\ \vdots & \ddots & \vdots \\ \frac{\partial a_{n1}}{\partial a_{ij}} & \cdots & \frac{\partial a_{nm}}{\partial a_{ij}} \end{bmatrix}$$

The δ-vector with respect to the element y_s is the vector of derivatives:

$$\delta = \begin{bmatrix} \frac{\partial y_1}{\partial y_s} \\ \vdots \\ \frac{\partial y_m}{\partial y_s} \end{bmatrix}$$

So, the element Δ^{ij}_{pq} of the Δ_A matrix and the element δ^s_l of $\vec{\delta}_Y$ are well known Kronecker symbols:

$$\Delta^{ij}_{pq} = \begin{cases} 1, & \textit{if and only if } i = p \textit{ and } j = q \\ 0, & \textit{otherwise} \end{cases}$$

The usage of the Δ matrix and the δ-vectors permits easy calculatation of the sensitivity functions (derivatives) of the $\vec{X}$ with respect to elements of the matrix A and the $\vec{Y}$:

$$\frac{\partial X}{\partial A} = \Delta_A \times Y \text{ , and } \frac{\partial X}{\partial Y} = A \times \delta_Y$$

As an application of this symbolic technique, a linear ecologo-economical systems are considered:

$$\begin{cases} X = AX + Y \\ Q = BX + q \end{cases}$$

where X is $1 \times n$ vector of industrial outputs, Y is $1 \times n$ vector of industrial demand, A is $n \times n$ input-output matrix, Q is $1 \times m$ vector of pollution, q is $1 \times m$ vector of abatement and B is $n \times m$ matrix of relative sectional pollution.

ESTIMATION OF ENVIRONMENTAL POLLUTION RISKS

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Estimation of environmental pollution risks is necessary for creating the basis for fixing tariffs of ecological risks insurance, which is determined as ecologically dangerous businesses responsibility insurance and mercantile interests insurance, arising in the case of emergency of environmental pollution. Ecological risks estimating includes such components as regidration of objects, affecting environment, pollution accident statistics analysis, quantitative characteristics of pollution probability and consequences.

In its initial stage pollution risks estimating methods are founded on robust method: if mass of bad water of the kind i is greater or equally divisible value of permissible rate, the environmental pollution risk exists, and the enterprise must be graded as an ecologically dangerous object, and it is to be insured without fail. This conditions must correspond to the inequality:

$$M_i \geq \tau_i \cdot PDV_i$$

where:

M_i - the mass of bad matter if the kind i, outgoing (at once and/or successive?) into environment in consequence of potential ecological accident, tons per year;

PDV_i - permissible limit of bad matter of kind i atmosphere pollution, tons per year;

τ_i - divisibility of excess permissible limit of the bad matter of kind i pollution.

On the basis of these methods a diagnostic method for revealing environmental pollution risks has been created. It uses the estimate of relative danger of bad admixture presence in the environment.

GLOBAL CO_2-INDUCED WARMING: IMPACT OF COUNTRIES AND REGIONS

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Problems of global warming are connected with the growth of atmospheric carbon dioxide. Parameters of carbon cycle change under anthropogenic activity for atmosphere, ecosystems, countries and regions were calculated using a spatially distributed carbon dioxide model. Global CO_2 budget for atmosphere, several countries and regions was calculated with the help of spatially distributed model of carbon cycle.

The model is described by a set of ordinary nonlinear differential equations. In the model the entire territory of the planet is divided into cells 5x4 deg. of geographical grid. We assume each cell of land to belong to one of the 30 types of ecosystems. Carbon cycle in atmosphere-ocean system is described by zonal model in which ocean surface is subdivided into latitudinal zones.

Using model cells aggregation the following countries and regions were chosen: Russia, USA, Canada, Europe (without Russian part), China, Japan, Brazil, Mexico, Australia, Bolivia, tropical forests. Model calculations were made for the period of 1860-2025. Effects of fossil fuel burning, deforestation and soil erosion were calculated.

Calculations show that during the period of 1860-1980 and up to 2025 land ecosystems are the sink of CO_2 (in spite decrease of humus amount). It is necessary to point out the major role of increase of plant productivity connected with the growth of atmospheric CO_2 concentration.

Carbon budget in 1980 for countries mentioned above was calculated. The territories of Canada, Australia, Brazil had a positive CO2 budget, these countries were sink of CO_2. The other countries are the sources of CO_2.

ECONOMIC-MATHEMATICAL MODELS OF FOREST FARMS

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The task of sustainable development of taiga forests surrounding urbanized areas in the Baikal region calls for changing the present way of life--improving the nutrition and health of people by using the riches of the east-Siberian taiga, which include clean water and air, mineral resources, phytoresources, and wild animals given to taming and domestication.

One of our suggested areas of work is to give damaged forest areas closer ties to zones of recreation and health improvement for the development of such branches as the breeding of wild animals and the restoration of traditional crafts. This is based on the study and generalization of the experience of ethnic farming and methods of inexhaustible nature use practiced in different regions.

The raising of wild animals--a non-traditional branch which works on more full use of the resource potential of forest lands, on supporting the biodiversity of taiga landscapes, on the enrichment of the productive complex of the region and variety of products for the processing industry (leather, down and fur, pharmaceutical, etc.), and on raising the effectiveness of local health improvement complexes. Wild animal raising allows for the possibility of obtaining pure products elk milk, meat, young horns, skins and fur, musk, etc. (without hormones and harmful chemicals) in comparison with traditional livestock products, combining ecology and business.

In one of the branches of economics, known as wild animal raising, effective techniques for keeping wild animals in captivity and solving problems of their domestication have been worked out, however there is no experience in the Baikal region in breeding wild animals by these methods, as has been done abroad.

We consider it fully worthwhile to put forth the issue about coming up with a perspective outline for the development of

forest farms according to the nature-resource potential of the Baikal region. This proposal has received the support of farmers interested in non-traditional branches of farming. In order to work out the techniques for wild animal raising it is necessary to establish a network of forest farms on which would be combined farm and scientific work under strict environmental control.

A study of the literature (1932-1994) resulted in the data Base formation: a history of domestication of wild animals, experience of Siberia's indigenous people and previous generations in production of different ethnic food traditional crafts. Data collection permits to develop information space for forest farm modelling in the Baikal region. Forest farm of different specialization may be considered as alternative ways for people employment (as wild animal raisings) in a region with special ecological requirements. Having studied the Russian experience in domestication of elk we propose to check the efficiency of a forest farm by means of models on personal computer (PC). Optimization of the nature use processes related to the solution of modern technical and technological objectives means return to the traditional crafts, quite in new stage, adapted to the local conditions.

These forest farms must have regional legal acts. These farms can be both raising of forest animals (elk, roe-deer, musk-deer, rain-deer, etc.) and of steppe ones (great busbard, wild turkey, camel, musk-ox, horse, goat, etc.), as well as wild plants.

A draft "Siberian Forest Farms as an element of the Model of the Sustainable development of the Lake Baikal Region" is presented in 1994 for a competition to the Ministry of the Environment Protection and Natural Resources of Russia (Moscow), International Ecological Fund and President Administration. Two reports are presented to NATO Advanced Research Workshop (Ulan-Ude, Sept 11-17, 1994) and Symposium (Irkutsk, May 1994).

SUSTAINABLE DEVELOPMENT AND OPTIMUM CRITERION IN MACROECONOMIC MODEL

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The experimental calculations in accordance with a simulation dynamic input-output model of the national economy have made it possible to trace the reaction of the national economy to the realization of various groups of environmental protection programs by the year 2005 [1].

The first group includes five environment protection programs. The programs differ in their final aims - by the year 2005 to achieve in all branches either advanced or standard levels of the purification of waste products, as well as by the pre-set trajectories of the development of the purification processes. One of the versions presupposes the achievement of the advanced level of purification not in all branches, but only in four of them (chemical, timber, light and food), for in the process of calculations by the model it has been revealed that at the beginning of the plan period these industries were responsible for 80 per cent of the load on the recipients, and that the respective figure for the year 2005 is 70 per cent.

As a result of calculations, all versions appeared to be realizable. It should be pointed out that in the course of the further analysis of the results of the solution it is necessary to take into consideration not only descriptive factors but also the effect of the negative features common for all the dynamic input-output models: the leap-type dynamics of some endogenic input-output models (especially of the indicators of capital investments and the commissioning of fixed production assets); it being non-optimal, i.e. the same or greater amounts of the final product could be obtained with less production expenditures of the gross product and of the fixed assets.

Then we determine the best version of the environment protection programs in accordance with criterion of economic efficiency: $Y - Z \rightarrow \max$, where Y is precluded economic damage from the pollution as compared to the initial version, Z - additional expenditures for the program as compared with the initial version.

Here the version with the purification only in four branches appears to be the most effective one. The efficiency criterion corresponds to the task of searching for the economic optimum of pollution.

But criteria of economic efficiency and of economic optimum of pollution don't correspond to sustainable development concept.

The first criterion of the sustainable development is connected with the economic growth and in our case this criterion is realized. Data on the final product, corresponding to the social target-oriented standards, are introduced into the model to check the possibility of producing this final product with the available capital investments and labor and material resources.

The second criterion of the sustainable development is connected with the question on the permissibility of the obtained summary values of the relative load on the recipients, created by the environmental pollution. In fact, this is the question of the criterion of the quality of the environment.

One of the possible approaches towards the evaluation of the permissible summary load is based on its comparison with the general load value, corresponding to a certain period, which might be considered satisfactory from the point of view of the state of the environment. Some researchers take the year 1965 as such a period.

Taking into account that the summary load on the environment in all our versions for year 2005 is more than one in year 1965, the optimum criterion in sustainable development aspect for our model is $Y' \rightarrow \min$, where Y' is economic damage from the pollution. We have another optimal version in accordance with this criterion. In this version the final aim of the environment protection program is to achieve the advanced level of the purification in all branches by the year 2000. Thus we must modify the computational model criterion if we base on the sustainable development concept.

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SUSTAINABLE INNOVATION AND REGIONAL DEVELOPMENT

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To cope with future organizational and regional demands, economic development has to improve effective methods of sustainable innovation and quality management. This paper analyses various managerial skills to understand and to support the process of microeconomic innovation ands its relations to multiple regional chalanges. This has to include development of (a) information and communication systems, (b) personel and managerial qualification, (c) strategies of implementation. The main toptics of the study are:

- Innovation and risk evaluation
- Multiprocess and multiproject management
- Quality management in terms of sustainable problem solving
- Integration of “Environmental Quality Management”

RETURNING VALUE TO NATURE

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To get anywhere close to a solution to the global ecological crisis that we are facing, we as a society must drastically change our value system. Under the traditional socialist economic theory, natural resources and the environment have use-value, but not value proper which is claimed to be generated only with human labour. Similarly, under market economics, natural resources and the environment are regarded as public goods whose use are non-exclusive and for which payments are impossible to collect from individual users. The effects of economic activities on nature are treated as externalities which are not valued in cost-benefit analysis. The zero-value given to nature has lead to its rampant non-compensatory use in both centrally planned and market economies.

Nature definitely should have value even under the socialist economics. Modern industrialization has come to such an extent that many natural resources and environmental services have been used beyond their capacity to regenerate. For human survival and social stability, human labour is increasingly required to repair damaged ecosystems, as demonstrated by growing public environmental expenditures in many countries. To conserve nature, therefore, is to save value generating human labour. In this sense, (to prove this the other way round), nature contains an unexpressed element of human labour; once nature is destroyed, human labour is required to make up for the damage (even though the damage may be beyond repair). Labour is valued here from a social perspective (socially necessary working hours) under the socialist economics.

Modern market economics has a shallow theoretical basis for the discussion of value. We often hear the saying: "economists know the price of everything, but the value of nothing'. Market economics focuses on market forces and price determination. But market prices do not necessarily reflect the underlying values from a social perspective. They are the result of interactions between buyers and sellers as individuals. The effects of production and consumption on nature, a public good, are not taken into account in such interactions. Market by itself is not capable of reflecting social value in price determination.

In any effort to return value to nature, public authorities must play a difficult but critical role. Vested interests exist in any

society. In capitalist economies where the private sector accounts for the majority share of social production, the resistance is inherently strong due to the short-term, profit driven property of the private sector. Elected politicians are also often influenced by the interest of the private sector (fortunately, NGOs and other social groups are now counteracting the interest of the private sector). In socialist societies where the public sector accounts for the majority share of social production, lack of profit-incentives does lead to inefficiency and waste, but there is no inherent incentive for maximizing individual profits (at the production level) at the cost to the society as a whole. The problem here is more of a corruption, mismanagement, and whether governments in those societies truly represent the interest of the society as a whole, including the interest of future generations.

Various techniques for valuing nature are becoming available, but this is not the main issue here. The principle is that governments must strongly intervene in the market to give value to nature, be they in a socialist or capitalist society. This implies that prices of goods and services should not be left entirely to the market. Social prices, which take into account the criteria of both efficiency and equity (within human society and between human and nature) have to be applied in any economy in order to return value to nature. This should be a social process in which representatives of various segments of a society give weights to various important aspects in their quality of life, including consumption level, political freedom, health, security, a clean living environment, etc.

Accordingly, to measure the progress of a society, a broad set of indicators reflecting ecological, social, and economic conditions should be used. Reforming the System of National Accounts (which produces GDP and national income figures) to take account of cost to nature would be a step in the right direction. But this is not adequate because values can not be fully reflected by prices. Ecological indicators and social indicators/indexes in non-monetary terms must be applied to reflect the value placed by a society on the relationship between human and nature and on the relationship within the human society.

INITIAL PRINCIPLES AND COMPUTER TECHNOLOGY OF COMPLEX RATING OF POLLUTION EXHAUSTS TO RIVER-BASIN

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In this report a computer technology of complex rating of pollution exhausts to river-basin is considered, which uses a new method of calculation of limit-allowable load.

Now the technology of rating of quality is based on calculation of limit-allowable exhausts (LAE) for single pollution sources.

This approach has itself virtue - it is simple in calculation and use concerning not much initial data. And LAE is calculated for three years as a constant. However, hydrological characteristics of river-basin are considerable changing during year. Consequently, there is necessity to set limit exhausts how diagram for different time periods. Now the calculations of limit-allowable exhausts don't take into account also:

- complex impact to part of river-basin of all enterprises (pollution sources), which are disposed on abutting territory;
- existence of non-control pollution exhausts or direct to pond, or to relief with consequent run-off (surface or ground), and also coming of pollution substance how result of secondary bottom processes.

In consequence of, we have situation on practice, when real background pollution of river-basin don't correspond by level to value of take into account exhausts.

So, we have necessity to improve of rating technology on base complex registration of group's load to part of water-basin, when hydrological conditions are changing. On practice this result to follow consequences: first, calculation schemes and algorithms are changing, that is other calculation method is necessity; second, type and quantity of initial data are changing too; and third, technology of use of methods and calculation criteria are also change both for regional ecological committees and for industrial enterprises - pollution sources.

A INTEGRATED LAND USE PLANNING MODEL FOR SUSTAINABLE DEVELOPMENT IN SEMI-ARID REGIONS: A STUDY FROM INDIA

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Conservation of natural resources, particularly land, water and forests which ensures food security and environmental quality is crucial for sustainable development in semi - arid regions. Sustaining soil quality is the outcome of land use over long periods of time. Since interactions across resources and activities are significant in the long run, we need a dynamic analysis for optimal land use. The objective of this paper is to suggest an optimal land use plan that integrates different production systems, namely, crops, livestock and forestry at a regional level.

The model is formulated in a dynamic linear programming frame work for the district of Ranga Reddy in a semi-arid region of Southern India. The objective function of the dynamic model is to maximize the discounted sum of the aggregate net value of output of the district in terms of both income and energy from various land use and livestock activities. Constraints under which the dynamic model maximizes the objective function over time relate to a) land area and quality, b) livestock dynamics, c) irrigation and water balance, d) integrated nutrient management, e) plantation dynamics and finally f) food and fuel constraints.

Soil loss and soil depth constraints are incorporated as the determinants of land quality. Livestock dynamics is modelled in terms of breeding efficiency and optimal feed and fodder requirements. Ground water depletion and augmentation possibilities are considered for irrigation. For soil fertility management, both dung and chemical fertilizers are taken into account from various sources. Orchards and forestry plantations are incorporated on the basis of their turn over . Thus livestock and forestry are integrated with crop production and horticulture. These in turn linked to food and fuel demands of growing population.

The dynamic model is estimated for a time horizon of 15 years, 1986 through 2000, using two discount rates, 12% and 5%. Solution of the model incorporating soil loss constraint, 5% ground water exploitation every year to the existing draft and no minimum forest area constraint is taken to be the base run. The results with respect to various sustainability conditions on income/energy, land use and livestock carrying capacity for the year, 2000 AD are presented in terms of two alternative objective functions, maximization of income and energy. The results are compared and certain policy conclusions are drawn.

(a) If the soil loss is to be maintained and runoff has to be kept within the limits, at least 8.9% of land has to be under forests at 12% discount rate. The percentage of forest area is higher if energy is the objective.

(b) The land use pattern indicated by the model is as follows. For arable land, inter cropping and dry land horticulture is recommended. For non arable lands, forestry with Acacia Species and cultivated fodder is indicated.

(c) If soil losses is to be minimized, livestock population must be reduced. This is true for both income and energy model. The magnitude of reduction varies with the percent of area under forests and the soil loss.

STABILITY OF ANTHROPOGENIC BIOSPHERE

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Man's impact on nature has become a global concern. It has become too obvious that the preservation of contemporary technological factors combined with the current rate of depletion of our natural resources will have an irreversible and catastrophic effect on the biosphere. The basic question is whether there exists a theoretical opportunity to reach a sustainable development for mankind and the biosphere.

With this in mind, the world dynamics model was developed. The main distinctive feature of this model is that it takes into account the dynamics of technological progress and contains a detailed description of the biosphere and climatic processes. With the growth of technology, mankind is given the capacity to develop new more and more ecologically pure technologies. In the model, improvement of the old and the appearance of new sources of energy is taken into account. The growth of the human population is gradually limited by a general understanding that, the high level of life is incompatible with the environment, and will fall short of the need for global restriction of birthrates.

Ecological processes are described by a global spatially distributed carbon dioxide cycle model. All the land area of the Earth is subdivided into cells of 4x5 deg. on a geographical grid. Ocean surface is subdivided into latitudinal zones.

According to the model, the positive development of a civilization with high level of life and quantity of inhabitants during at least 1-2 centuries is possible. It is also shown, that the insufficient development of new technologies can result in the

biosphere degradation within the next 50 years.

It is obvious, that opportunity for positive development, which confirmed with the help of a model, remains a hypothesis. It seems that in the next several years, it will be for mankind to decide whether such way of world development is realistic.

Measures to realize positive way of development and to try to prevent degradation will be different.

THE POLLUTION COMBUSTION IN THE "JIU-VALLEY" INDUSTRIAL REGION OF ROMANIA IN THE PROCESS OF ENERGY TRANSFORMATION

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The present paper wants to point out some problems specific for the East-European countries, the most important being the opposition between the necessity of energy production and the pollution combustion during the energy production.

Approaching an industrial region like an ecosystem means to make a systematical study, which offers the possibility to establish pollution level, to find the polluting processes and the contributing elements by the pollution combustion during the energy transformation. A method for estimating the pollution degree in the "Jiu-Valley" coal mining industrial region of Romania is given, with the remark that the present method could constitute a general algorithm for calculating the pollution in similar ecosystems.

In which way can be approached an industrial region like an ecosystem? How can be estimated the pollution degree of an ecosystem? Don't mean pollution degree of an ecosystem the distance between the nowadays situation and the steady-state of an ecosystem? All these are questions to be answered in this paper.

Building a system for modelling an industrial region, it is created the possibility for computer simulation and for making scenarios for a future developing, controlling through mathematical calculations (on the first step) the pollutants emissions. The solutions for reducing the environmental pollution could be established and also the strategies, which are to be followed in order to obtain a sustainable development of a region situated in Romania.

SUSTAINABLE DEVELOPMENT AND PUBLIC POLICY IN RUSSIA

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In traditional neoclassical analysis special attention is given to markets. Scarcity is measured by using the market price which is a result of the economic activities of producers and consumers who sell and buy goods and services at the market. Scarcity can only be measured in this approach as far as it is reflected in market prices. Labour, capital and natural resources which are traded at a market such as oil and iron ore normally have a market price which can be used as an indicator of the scarcity of the production factors and of the willingness of the consumers to pay for these goods. Such an approach can work adequately as long as the scarcity of unpriced nature and the environment are not relevant.

Pigou (1920/1952) was the first economist to recognise the shortcomings of this approach. He argued that the negative external effects of production and consumption on other than the current market parties have to be brought to the burden of the polluting industry. The authorities have to calculate the environmental costs and should implement a levy to be paid by the polluter: the polluter has to pay! In modern societies such a system can hardly work; there are too much uncertainties in the functioning of the ecosystem. Additionally, dose-effect relationships are hardly known and pollution is often transboundary.

The shortcomings of the traditional approach made it necessary to develop another type of reasoning aiming to reduce pollution considerably. In 1987, the Commission on Environment and Development introduced the concept of sustainable development which has been accepted by the majority of nations and international organisations. In this paper it will be questioned whether this approach can work in a Russian situation.

DE-MATERIALIZATION AS A NEW POLICY ELEMENT FOR SUSTAINABLE DEVELOPMENT IN CENTRAL AND EASTERN EUROPE

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This paper focuses on new aspects of eco-efficiency: options to increase the productivity of resources with the aim to protect the ecosphere. The paper is organized in three main sections. Section I describes a de-materialization approach which is development at the Wuppertal Institute (Schmidt-Bleek, 1994). The aim of the de-materialization strategy for sustainable development is to siow-down and to reduce the man-induced movements of materials. Goods and services need to be dematerialized by an average Factor of 10 on a cradle to grave basis (over the whole life cycle). This reduction should not lead to a deterioration of material welfare, became increasing material productivity is a major strategy of an efficient dematerializytion strategy. In order to reach the enormous requirements with respect to matter-throughput necessary for a sustainably development, "normal" environmental policy will not suffice (Hinterberger/Luks 1994).

Section II describes environmental policy in the East-European transition economies. (WELFENS, 1993, REC 1994, ZYLICZ 1994). These policies focus on the output side. The aim is to reduce emissions within a critical loads strategy (eg. VAN DER STRAATEN, 1992). But this strategy is not sufficient for sustainability in Eastern Europe. A new orientation in the environmental policy in the joung market economies in this part of Europe is required: The new environmental policy would take into account the interests of future generations, global aspects and is concerned with the long term stability of the ecosphere. This policy should focus on the sources of the material-energy flows asopposed to environ mental policy currently in practice.

Section III discusses options for a new design for environmental policy. Environmental politics based on regulatios, limitations and prohibitions by itself will not worldwide. Tax reform and a reform of the subsidy policy, new product design and new liability rules are some instruments of the new environmental policy.

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