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METHODOLOGY FOR ECOLOGICAL ECONOMIC SYSTEM EFFICIENCY EVALUATION

Abstract. Ecological economics assumes the organic unity of the ecological economic system both at macroeconomic and microeconomic levels. It reveals the main tensions between economic requirements and ecological imperatives and finds the ways of overcoming these tensions both at the sector and territorial levels. Natural resources and ecosystem services should be considered within the framework of the unified ecological economic system. The human use of the environment should be understood as a threefold process of sustainable use, protection, and regeneration of the ecological economic system. The goals of preventing the loss of ecological potential and achieving sustainable development may be reached by two ways: the first is to bring the production technology into correspondence with ecological imperatives; the second is goal-oriented environmental protection activity. The ecological-economic effect is based on the net economic effect of the production-economic activity minus ecological costs and losses. The notion of «ecological economic cost-effectiveness» equally corresponds to the development laws of society and nature and therefore satisfies the principle of sustainable development. Forest presents a very good model for the eco-economic system. The problem of ecological economic cost-effectiveness in forestry is so complex that the approach used to solve it can illustrate the possible ways of ecological economic problems solving in general.

Introduction. Economy and ecology do not just possess the same linguistic root. Interconnections exist between these two systems also. In the second half of the 20th century these interconnections have became so obvious that nowadays it is widely accepted that it is reasonable to consider economic and ecological systems as a unified ecological economic system. Such a postulate is easiest to understand at a macroeconomic level. In the long term any society has to pay for the negative ecological consequences, caused by the production-economic activity of enterprises and firms of different branches of the economy [3-12]. The costs of environmental protection, the treatment of air and water, as well as soils and other components of the biosphere are currently covered mainly from the state budgets in Ukraine and in other transitional countries. At present, firms and enterprises do not bear direct responsibility for the environmental degradation and other negative ecological consequences of their activity. This results in environmental protection being the concern of the state, society and taxpayers, not for the environmental polluter.

The unity of the ecological-economic system is more difficult to understand at a microeconomic level. Microeconomics, which studies the activity of small economic structures – households, firms and governmental agencies – does not accept such a unity. Ecological costs and losses are treated as external to the activity of households and firms. Moreover, household, firms are not willing to include these expenditures in the cost of their production, as this therefore increases the price of products and decreases competitiveness and income.

Ecological economics assumes the organic unity of the ecological economic system both at macroeconomic and microeconomic levels. It reveals the main tensions between economic requirements and ecological imperatives and finds the ways of overcoming these tensions both at the sectoral and territorial levels. Also, it could be argued that the economic system is more dependent on the ecological one than vise versa [2].

The problem has been stated in the following terms: «Any system is developing at the expense of the environment. In any environment, as in a supersystem, the compensatory reactions, able to sustain its destroyed homeostasis, are generated. Until the intensity of the destruction is less or equals the environment's capacity to withstand them, the development continues «conflict-free». However, when the destruction exceeds constructive processes, the crisis of the relations between the system and its environment occurs. And, as in the «system-environment» the first component always depends on the second, the destruction of the environment inevitably turns into a catastrophe for the system. Hence, the nature – the environment of life for mankind – is of highest value. The loss of the environment of life would mean the death for all the people, and it would happen «before the nature would die» [1].

The cause-consequence relations interconnect economic and ecological subsystems of the general system. Development, stabilization and degradation of each one of these subsystems, influences the other. Moreover, degradation of the ecological subsystem always implies degradation of the economic subsystem. The degradation of both subsystems may happen either simultaneously or the economic subsystem may survive the ecological one for some time. Those who don't realize the importance of the cause-consequence relations between economic and ecological subsystems, will, however, eventually suffer the consequences. Continuing production despite the degradation of ecological subsystem will inevitably lead to the collapse of the economic subsystem.

Environment and Natural Resources in the Unified Ecological Economic System. The environment includes all five main components of the biosphere: land, water, fossils, plant and the animal kingdoms, and air space. The environment includes man himself, who is a part of living nature. The environment can be divided into life support services and natural resources which represent the potential raw material base for material production. Life support services of life and natural resources form the unified natural material basis for both the economic and ecological systems [8-12]. However, a traditional economic system is interested only in natural resources, which represents the present or potential raw material base for the different branches of economy. As for the non-resource components of environment (such as solar radiation, air, water, and other components of the biosphere that are not used directly in the production process, they are considered to external to the economic system). However, the environment, including life support services, natural resources and a mankind, makes up a unified ecological system at all scales- global, regional, and local.

Disregarding the life support services component results in a non-rational use and depletion of the natural resources component and causes a decrease in the long-run ecological potential, of the whole ecological system. Thus, the economic system should include not only the resource part of the biosphere but the life support services as well.

Sometimes it is practically impossible to distinguish between life support services and natural resources since the same components of the biosphere (e.g. land in agriculture and in forestry) act simultaneously in both. But the division into two components is important from a methodological point of view.

It is important to underline the fact that life support services are connected with the economic system not only by cause-consequence relations. The life support system also acts as a supersystem in relationship to the economic system [1]. That is life support system, as ecological systems, should become a priority from the point of view

of ensuring sustainable development. Natural resources and life support services should be considered within the framework of the unified ecological-economic system. These components are integral parts of the economic process of material goods production as well as important factors in forming GNP and the national wealth.

Life support services suffer considerable damage due to the productive activities of man, both through pollution and through extraction of raw materials. The human use of the environment should be understood as a threefold process (fig.1) of sustainable use, protection, and regeneration of the components of production – life support services and natural resources (the ecological economic system).

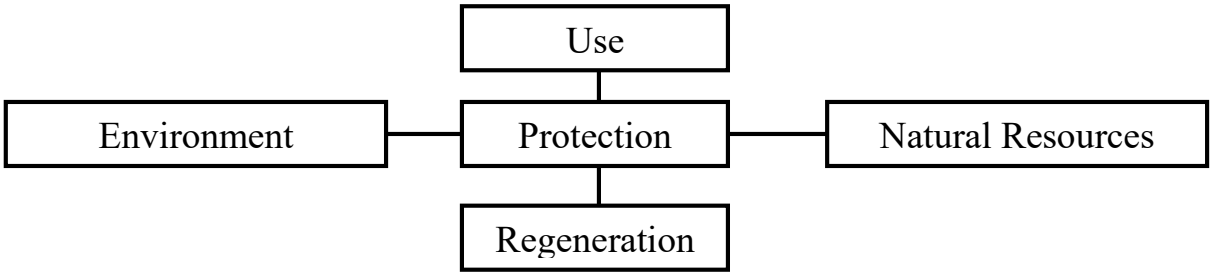

Fig. 1. Environment and nature resource use system

In ecological economic system economic system always depends from ecological system (fig. 2). Each subsystem goes through the development, stabilization and degradation finally. The degradation of ecological subsystem (as result of human activity or under influence of natural factors) leads finally to the degradation of economic system. Therefore it is important to avoid the degradation of ecological subsystem of ecological economic system. It's a condition for sustainable development of any territory.

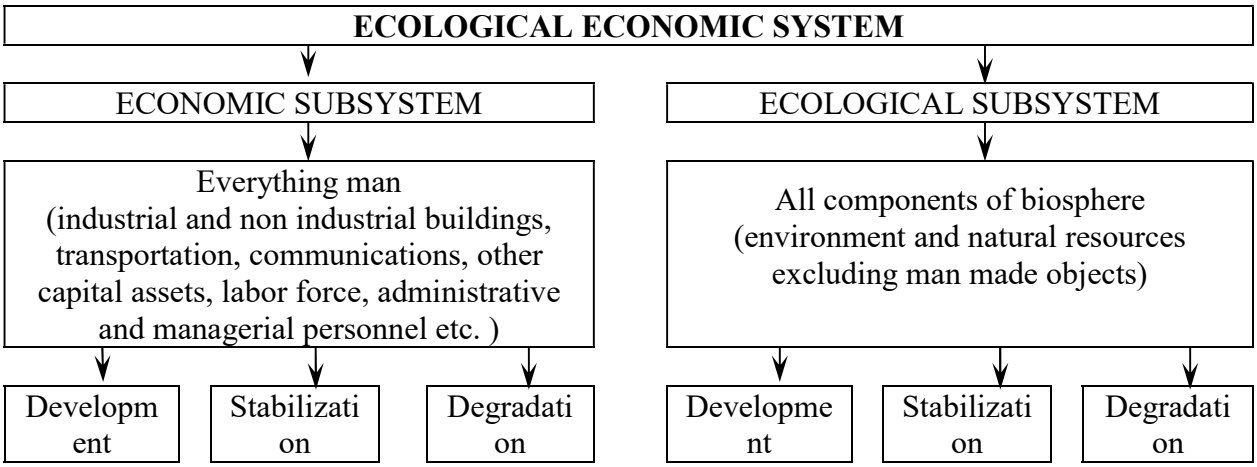

Fig. 2. Structure of ecological economic system

For our opinion, new models of the economy development should be developed and implemented on the basis of theory of ecological economics about a unity of ecological and economic system. There are unity, contradictions, interrelations, and interdependences among economic system and ecological system which calls greening of economic theory and economic rethinking of ecology and other natural sciences.

Effects of the Interaction of Economic and Ecological Systems and Their Classification. The interaction of the two life-ensuring systems – economic and ecological – in the production of goods and services is accompanied not only by a desirable economic result but also by an attendant ecological one. Ecological effects mean any

changes in quality of the environment of life as well as in the quantity and quality of natural resources, in space and time. Such changes may be either positive or negative in character – improvement or worsening of the natural conditions of life, increase or decrease of the natural resources quantity and quality. Ecological effects influence or can have future influence on the economic results of material production and on the non-production sphere.

Ecological effects are characterized by, at least, eight indicators:

- origin (natural or technological);
- form of manifestation (obvious or concealed);
- possibility of quantitative measurement (measurable or non-measurable);
- character of interdependence with a traditional economic effect;
- possibility of forecast (forecasted or non-forecasted);
- possibility of the return to status quo (reversible or irreversible);
- time lag;
- duration.

The most dangerous effects are concealed as non-forecasted ones which can arise unexpectedly, inflicting great losses to an economic system and even causing victims.

The classification given in table 4.1 has a practical significance. It allows us to define the character of ecological effects and to undertake necessary measures to prevent undesirable ecological effects.

Table 1. Classification of ecological effects

Defining principle for the pair of effects	Type of effects	
	First (+)/(–)	Second (+)/(–)
1. Origin	natural (happening for natural reasons)	artificial (caused by human activity)
2. Forms of manifestation	obvious (visible or outwardly perceptible)	hidden (concealed, not perceptible or seen outwardly)
3. Capacity of quantitative evaluation	measurable (the one which could be measured quantitatively)	non-measurable (cannot be measured quantitatively)
4. Character of interdependence with economic effect	spontaneously turning into economic effect (directly transformed)	indirectly connected with achieving economic effect (indirectly transformed)
5. Time lag	coinciding in time with the achievement of economic effect	not coinciding in time with the achievement of economic effect
6. Capacity to reverse	reversible	non-reversible (only negative)
7. Durability	short-term	long-term
8. Possibility to foresee	can be forecasted	can not be forecasted
9. Scale	Local and regional	global
10. Motivation	Deliberate	unintentional

There are ten pairs of effects in fig. 3. Taking into consideration the fact that they can be either negative or positive total number is forty. All of them are dynamic and can transform into each other. Effects of natural origin could be produced by human labour (artificially). Hidden ecological effects become evident with time and visa versa – the evident one can become hidden. An ecological effect, which is at present only indirectly connected with the achievement of economic results in production, tomorrow can have direct influence on the economic results of this production.

Economic «Law» for Ecological Costs. Ecological costs are the total combination of expenses and losses in the sphere of environmental use and environmental pro-

tection. This is one of the fundamental notions of ecological economics. Ecological costs of material production and non-production sphere include:

- direct costs of environmental protection, treatment of air and water lands, and other components of the environment of life;
- costs of timely quality regeneration of the environment of life degraded by destructive changes;
- losses connected with irreversible negative effects on the environment, quantity and quality of natural resources;
- losses connected with the necessity of reserving, for environmental protective purposes, objects of nature, which could be exploited and yield real economic effects;
- additional costs in connection with the development of natural resources under worsening conditions and resources remote from the centers of direct consumption;
- relatively high costs of processing secondary and low grade raw materials into commodity products in order to save the good quality raw materials;
- costs of extended regeneration of renewable natural resources, as well as for research and the creation of substitutes for non-renewable resources;
- general costs of fundamental and applied scientific-research and design works in the sphere of the environment of life and natural resources, formal and non-formal ecological education of the population.

Due to the worsening of global and regional ecological situations, ecological «costs» have tended to increase both on the national and global scale. One may assert that there exists an economic «law» of the increase of ecological costs to society. The «law» states that there is an inevitable increase in space and time of the costs of material production, the non-production sphere on the protection, use, and regeneration of natural resources and quality of the environment of life conditions.

The economic «law» on the increase of the ecological costs to the society reflects objective cause-consequence relations existing between the level of intensity of natural resource use, the level of environmental pollution and other forms of ecological system degradation on the one hand, and the necessity of adequate compensatory expenditures for the regeneration of life support services and natural resources, on the other hand.

The effect of this «law» is preconditioned by the fact that no activity can function without utilizing the natural resources of the planet and without having some environmental impact. Therefore, in the process of mankind's development, there arises the necessity for an increasing expenditure of money for ecological purposes. Ignoring the influence of this «law» on the economic system results in the degradation of the quality of life support services, in the depletion of the natural resources and finally in the need for new ecological expenditures to combat the increased probability of ecological losses. Thus, socioeconomic impoverishment follows. Application of this law in social practice at the global, national, regional, and local levels is a prerequisite for balance between ecological and economic systems, and for sustainable development to occur.

The law would appeared to be confirmed by empirical evidence, which demonstrates the relationship between intensity of the use of natural resources, the quality of life support services, and quality of human life itself. This law will be in effect until the reasons for its existence, such as non-compensatory use of natural resources and non-compensatory destructive changes in the environment of life, take place. It is possible to decrease its effect by optimizing the interaction between the society and nature. This requires agreed actions at regional and global scales. In order for such actions to become a reality, it is necessary to replace the traditional economic criterion of the evaluation of efficiency in production by a unified ecological-economic one.

In accordance with this law «ecological costs» should be included into the list of production expenditures. «Ecological costs» in the structure of the cost of production and services can perform a double function. First of all, it can forestall anti-ecological economic activity and stimulate rational use, protection, and regeneration of natural resources. Secondly, it can become a source of the replenishment of the funds, directed at the financing of the environmental protection and development of new ecologically safe technologies.

Principles for the Ecological Economic Evaluation of Environment and Natural Resources. The depletion of natural resources, implies loss of ecological potential, which it will be necessary to renew in the future. It is also implies the degradation of the life support services, which would have to be improved at the expense of future investments. The goals of preventing the loss of ecological potential and achieving sustainable development may be reached by two ways. The first is to bring the production technology into correspondence with ecological imperatives, to provide it with ecological orientation, and, to structurally entwine ecological factors in the fabric of the corresponding technologies. The second is goal-oriented environmental protection activity. These often overlap. In particular this overlap takes place in extractive branches of industry, in agriculture, forestry, water management, as well as other spheres of production activity connected with the use and regeneration of natural resources. Complete unification of these two ways will, in the future, become a new stage in the development of human civilization. In order to achieve this, we should be guided by principles for the ecological economic evaluation of life support services and natural resources – along the following times:

- The principle of complexity: the registration and evaluation of all interdependencies between life support services and natural resources in different territories and in their relationship.
- The principle of scarcity: weighting the relative scarcity of individual components and conditions of life support services and natural resources.
- In accordance with the requirements of these principles a comparatively higher weight is given to the irreplaceable, non-transportable life support services and resources, as well as conditions and resources, which are in shorter supply in comparison with others.
- The principle of the regional differentiation: this which envisages the different levels of evaluation of the qualitatively identical conditions of the environment of life and natural resources (space evaluation).
- The principle of evolution: evaluations and forecasts, should take into account possible changes in ecological and economic conditions in future. This can affect the relative scarcity of individual ecological services and natural resources.
- The principle of feedbacks: taking into account boomerang effects (negative ecological effects).
- This implies consideration in economic calculations of the mutual influence of economic activities on life support services and natural resources and vice versa.

Criteria for the Ecological Economic Cost Effectiveness in the Natural Resource Use. Production of goods and services toward to satisfying individual and social needs on the one hand, and the desire to maintain ecological conditions on the other hand, implies a new economic category – ecological economic cost-effectiveness or «ecoeconomic cost-effectiveness». Illustratively, the relationship between economic effects, reflects economic activity, and ecological effects is shown on fig. 4.3 on the coordinate axis are economic effects. On the abscissa axis – are ecological effects. This illustrates the notion «ecoeconomic cost-effectiveness».

Integral ecological-economic effect of environment of life, natural resources as well as of other production-economic activity is an algebraic sum of two different in nature effects – traditional economic and ecological ones. These effects are achieved, as a rule, with a different lag and, only in some cases, simultaneously. Traditional economic effect is, as a rule, positive while ecological one could be both positive and negative. The negative effect is the most urgent one.

The ecological effect reflects changes, in space and time, of life support services and natural resources under the influence of different factors. These changes may have both positive and negative character – improvement or degradation of man's life conditions, increase or decrease of the quantity and quality of natural resources.

The ecological-economic effect is based on the net economic effect of the production-economic activity minus ecological costs and losses. The notion of «ecological economic cost-effectiveness» equally corresponds to the development laws of society and nature and therefore satisfies the principle of sustainable development.

A rough measure of ecological economic cost-effectiveness is the ratio of the value of the integral ecological-economic effect of the production-economic activity to the sum of traditional economic and ecological expenditures.

The integral ecological-economic effect, achieved at minimum social costing, is an important factor in sustainable development.

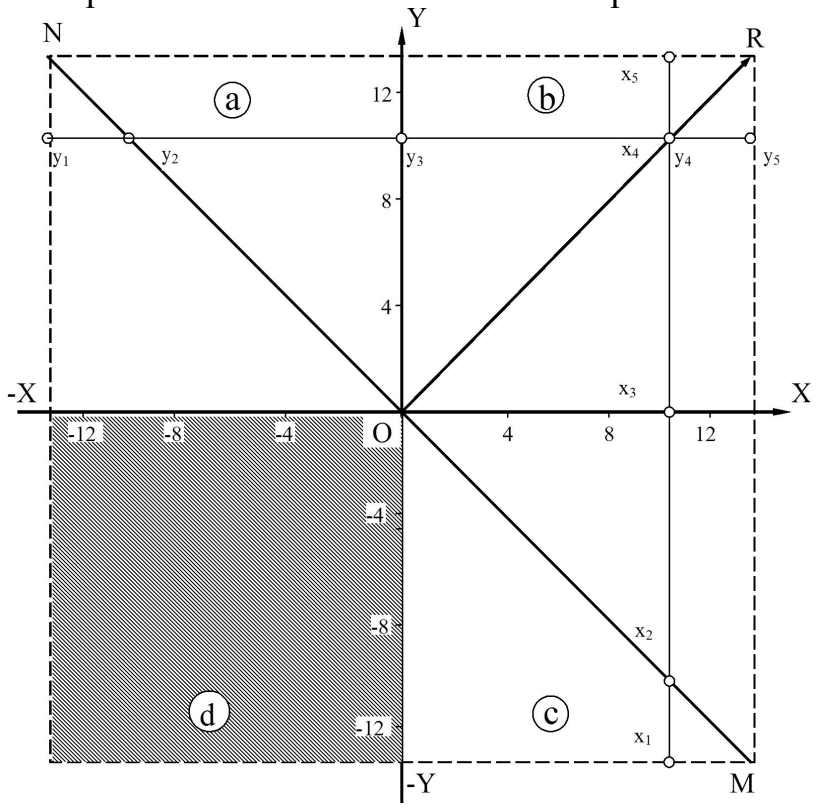

Fig. 3. The criterion of ecological economic "cost effectiveness" in production: X scale – size of the ecological effect; Y scale – size of the economic effect; NOM – discriminate of the positive and negative ecological economic (E-E) effect; OR – vector of the optimal E-E effect; XI, X2, X3, X4, X5 / Yl, Y2, Y3, Y4, Y5 – types of the hypothetical monetary value of the annual ecological economic effect in industrial activity.

The criterion for the efficiency of an economic system, (that will also satisfy the requirements for sustainable development), is the maximization of the integral ecological-economic effect.

A sample numerical example follows. Hypothetical evaluation of the ecological economic efficiency is carried out by means of the five-point scale in table 2.

The mathematical formulas for the evaluation of different types of production activity given in the table 2 are presented in the simplified form in the table 3.

Supposedly, there are five hypothetical types of technologies for the production of some product. In the real life the number of these types could be numerous. If we

calculate the results of industrial activity of the firm according to the traditional criterion of economic efficiency, then the annual economic effect of in all five types of activity, given in fig. 6, will be equal in value – 1 million dollars.

Table 2. Ecological-economic evaluation of economic production activity

No. of variant	VARIANT chosen	ANALYTICAL EVALUATION OF CONDITIONS		
		GENERAL	Natural Use	Nature Conserving Use
1	INEXPEDIENT	$\sum_1^T Exy < 0$	Ey – Ex < 0	- Ey > Ex
2	PERMISSIBLE	$\sum_1^T Exy = 0$	Ey – Ex = 0	- Ey = Ex
3	SATISFACTORY	$\sum_1^T Exy > 0$	Ey – Ex > 0	- Ey = 0
4	OPTIMAL	$\sum_1^T Exy$ = Ex+Ey	Ex = Ey	Ey = Ex
5	MONOEFFECTIVE	$\sum_1^T Exy$ > Ex+Ey	Ex > Ey	Ey > Ex

Table 3. Hypothetical monetary value of the annual ecological economic effect in industrial activity

Type of the technologies	Hypothetical value of the ecological economic effect		
	Natural use	Environmental conservation	General
1	Exl= -1400.0 Eyl=1000.0 ΣExy=-400.0	Exl=1000.0 Eyl=-1400.0 ΣExy=-400.0	ΣExy=-800.0
2	Ex2=-1000.0 Ey2= 1000.0 ΣExy=0	Ex2=1000.0 Ey2=-1000.0 ΣExy=0	ΣExy=0
3	Ex3=0 Ey3=1000.0 ΣExy= 1000,.0	Ex3= 1000.0 Ey3=0 ΣExy= 1000.0	ΣExy= 2000.0
4	Ex4= 1000.0 Ey4=1000.0 ΣExy= 2000.0	Ex4= 1000.0 Ey4= 1000.0 ΣExy= 2000.0	ΣExy= 4000.0
5	Ex5= 1400.0 Ey5=1000.0 ΣExy= 2400.0	Ex5= 1000.0 Ey5= 1400.0 ΣExy= 2400.0	ΣExy= 4800.0

In the traditional input-output formula of calculating profits (benefits) the specific type of technology producing 1 million dollars does not matter for the firm.

It does not matter for the firm which type of technology to use:

- The technology polluting environment, worsening the quality of ecosystems or even damaging it (type 1).
- The technology having less negative influence on the environment and producing benefits equal to ecological losses (type 2).
- The technology having no visible negative influence on the environment and producing net benefits without ecological losses (type 3).
- The technology doubling the unified ecological economic effect due to improving the quality of environment in the course of production (type 4).

- The ecological technology causing larger positive ecological effect than the traditional economic one (type 5).

As I have mentioned before, in the traditional criterion, it makes no difference for the firm which type of technology will produce 1 million dollars. But, if we use the new ecological economic criterion, which is the key concept of the ecological economics, then it will turn out that public efficiency (net efficiency) of these 5 types of technologies will be far from equal. In the first type of production $1 million of benefits for the firm will turn out into $ 400,000 losses for the society (see fig. 6).

This happens because to compensate for ecological losses, caused by this type of technology, the society will have to spend $ 1,400.000. The benefits of the firm are $1 million, but the losses to the society are $ 1,400.000. The difference according to ecological economic criterion is 1,400.000 -1,000.000 = -400. In the second technological type $1 million of benefits will turn out into zero benefits for the society. All the benefits should have been spending to compensate for ecological losses, caused by the industrial activity of the firm. So the future ecological costs to the society will be equal to the benefits of the firm.

The difference according to ecological economic criterion is 1,000.000 – 1,000.000 = 0. In the third technological type the benefits of the firm will be real, as its activity have not caused ecological losses. The benefits of the firm will not cause any losses to the society, as there will be no ecological losses. The difference according to ecological economic criterion is 1,000.000 – 0 = 1,000.000.

The fourth type is even better, it could be called the 'optimal' one, as it satisfies both ecological and economic requirements. However, it is extremely difficult to achieve this type of technology in the real life. In this type the benefits cause the equal positive ecological effect. The difference according to ecological economic criterion is 1,000 000 + 1,000.000 = 2,000.000. This fourth type satisfies the sustainable development principle announced by Rio-92. This type of technologies should be a final goal for the individual subjects of national economics (firms), international firms as well as for the countries as it provides for long term sustainable social economic development.

And, finally, the fifth type is possible. In it the positive ecological effect exceeds the traditional economic one. The difference according to ecological economic criterion is 1,000.000 + 1,400.000 = 2,400.000.

Ecological Economic Criterions for the Evaluation of Natural Resource Use: Forestry as a Case. Forests can be considered a biologically renewable natural resource, i.e. they have capacity to regenerate themselves. At the same time, forest and forest resources present a very good model for the eco-economic system.

The problem of ecological-economic cost-effectiveness of expenses in forestry is so complex that the approach used to solve it can illustrate the possible ways of solving ecological economic problems in general. The summary effect of investments into forestry can be divided into a traditional economic effect of timber sales, ecological effects of oxygen production and water regulation, and other useful functions of the forest. Thus, current forestry should be considered, on the one hand, as an organizationally formed, independent branch of material production and, on the other hand, as an integral part of the material goods production process. Understanding of these two aspects of forestry is important to any of the ecological-economics analysis. Economists have argued that the «timber age» has not come to an end yet, but that wooden raw material, probably, will become one of the scarcest biological resources in the future. However,

we should keep in mind that the forest is not only a source of obtaining timber. First of all it is one of the most important components of the biosphere. Scientific research has verified that forests synthesize more than 50 % of atmospheric oxygen produced by the vegetation of the entire planet. If we add to this other functions of the forest such as its influence on the water regime and climate and its protection of soils from erosions one should acknowledge that forests from a young age till their maturity have a real economic value for a society. As an independent structural component of the biosphere and an object of the economy, forests benefits for society which are connected among themselves as well as with the external environment. They may be divided into four main groups presented on fig. 4. Considering forest as the DMFR system, we try to embrace all the aggregate of its multilateral components – carriers of consumption value – and to take into account ecological factors while evaluating their use.

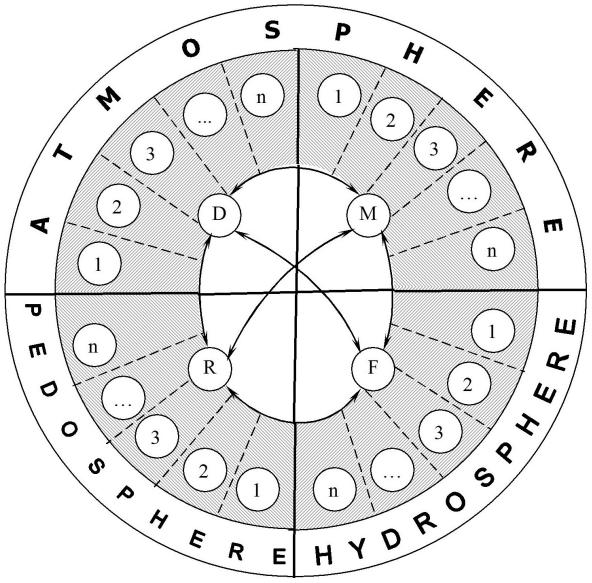

Fig. 4. The forest ecological economic system: the interrelationship of potential products and services, where D – raw material resources of wooden origin; M – resources of non-wooden vegetable origin; F – resources of animal origin; R – multiple useful functions (services) of the forest, its influence on the environment

Besides, one should keep in mind that DMFR system is closely connected with the external environment, first of all with pedosphere, hydrosphere, and atmosphere. That is why, the forest ecosystem should be considered as PHDMFRA system. All relations in this system are fulfilled through pedosphere, ground waters, and atmosphere. As we can see, forest, as a DMFR system is quite an obvious model for the unification of the economic and ecological systems into a unified eco- economic system. The process of the forest use is a mere reflection of the real process of the use, protection, and regeneration of biologically renewable natural resources.

In the table 4 the approach to evaluation of the different types of forest management development according to E-E criteria is illustrated.

Conclusion. Considerable worsening of the environmental situation at global, regional, and local levels has provoked a new way of ecological-economic thinking. It is quite clear that nowadays it is unacceptable to act in accordance with traditional views of human influence on the environment, and traditional methods for evaluating economic activity. It is necessary to develop new methods for the evaluation of

economic activity which are sensitive to the growing influence of the economy on its environment.

Table 4. Evaluation of forest management development according to E-E criteria

Types of development	Analytical demands on the evaluation according to E-E criteria			Evaluation of the development possibilities of forest management
	Use of forest resources	Reproduction and conservation	General	
1	Ey + Ex < 0	Ex + Ey < 0	$\sum_1^T EExy < 0$	Inevitable degredation
2	Ey + Ex = 0	Ex + Ey = 0	$\sum_1^T EExy = 0$	Lack of development
3	Ey + Ex > 0	Ex + Ey > 0	$\sum_1^T EExy > 0$	Satisfactory development
4	Ey = Ex	Ex = Ey	$\sum_1^T EExy = Ex+Ey$	Good development
5	Ey > Ex	Ex > Ey	$\sum_1^T EExy > Ex+Ey$	Very Good development

By applying the methods of natural and social sciences, engineering ecological economics attempts to find the interconnection between these sciences and the human intellectual ability to ensure sustainable development. In the future sustainable development may be achieved by stimulating preventive protection of the environment by ecological redesigning of all the spheres of production as well as meeting ecological requirements in all other fields of human activity. In order to achieve sustainable development, ecological effects should be included in the economic choices assessment.

Ecological economics points out the ways in which an economic incentives system may prevent environmental damage. It can also suggest levels of compensation for the inevitable ecological damages, which occur without the violation of environmental protection legislation. These damages should be compensated by the responsible industrial and commercial structures. Thus, ecological economics theory provides the ways for achieving the goals of sustainable development.

Environmental problems should be solved not only by specially empowered bodies, and relevant institutions but by society as a whole.

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Методологія оцінювання ефективності еколого-економічної системи

Між економічною та екологічною підсистемами єдиної еколого-економічної системи існує причинно-наслідкова залежність. Розвиток, стабілізація та деградація однієї з них неминуче позначаються на іншій. Традиційна ринкова економіка засадничо суперечить екологічним вимогам, тому нагальним завданням сучасної економічної науки має стати формування нової – екологічної економіки. Принципи екологічної економіки мають запанувати у всьому світі, адже планета Земля – цілісна взаємопов'язана глобальна еколого-економічна система. Оновлену економічну політику держав потрібно ґрунтувати на трьох основних складниках: екологічній моралі (виховання нової ментальності); екологічній економіці; екологізованому праві. Ці компоненти мусять бути визначальними для державних інституцій і політичних сил. Завдання економістів-екологів – обґрунтувати органічну єдність еколого-економічної системи як у макро-, так і мікроекономічному вимірах, виявляти основні суперечності між економічними та екологічними вимогами, запропонувати шляхи подолання їх на галузевому й територіальному рівнях. Домогтися сталого розвитку неможливо без економічно та екологічно ефективного виробництва у поєднанні зі зміною структури споживання. У багатьох випадках це потребуватиме переорієнтації існуючих систем виробництва та споживання (які склалися у промислово розвинених країнах і стали прикладом для наслідування у всьому світі) на універсальний еколого-економічний критерій. Екологічний ефект – це будь-які зміни якості умов природного життєвого довкілля у просторі та часі, а також зміни кількості та якості природних ресурсів. Вони можуть бути як позитивні, так і негативні. Від екологічного ефекту узалежнені економічні результати матеріального виробництва і невиробничої сфери. Для екологічних ефектів властиві такі ознаки: походження; форма прояву; можливості кількісного виміру; характер взаємозв'язку з традиційним економічним ефектом; синхронність; можливість повернення до статусу-кво; тривалість дії; прогнозованість; масштаби дії; мотивація. Негативний ефект може виявитися у вигляді прямих ресурсних втрат для національної економіки або у вигляді непрямих збитків, спричинених зниженням якості (пошкодженням) інших видів природних ресурсів, погіршенням умов природного довкілля (забрудненням, повенями, ерозією ґрунту тощо), шкідливим впливом на людське здоров'я .

Інтегральний еколого-економічний ефект природокористування чи будь-якої іншої господарської діяльності є алгебраїчною сумою двох різних за формами прояву ефектів. Інтегральний еколого-економічний ефект, якого досягнуто за мінімальних витрат суспільної праці і природного (екологічного) потенціалу, є важливим чинником орієнтації будь-якої економічної системи на забезпечення принципу сталого розвитку. Критерієм ефективності функціонування економічної системи, зорієнтованої на забезпечення вимог сталого розвитку, є максимізація тривалого інтегрального еколого-економічного ефекту.