dr inż. Katarzyna OSTASIEWICZ
Wydział Zarządzania, Informatyki i Finansów, Uniwersytet Ekonomiczny we Wrocławiu
e-mail: katarzyna.ostasiewicz@ue.wroc.pl

prof. dr hab. Walenty OSTASIEWICZ
Wydział Zarządzania, Informatyki i Finansów, Uniwersytet Ekonomiczny we Wrocławiu
e-mail: walenty.ostasiewicz@ue.wroc.pl

DOI: **10.15290/ose.2017.01.85.01**

ECOSOCIONOMICS AS A SUSTAINABILITY SCIENCE

Summary

This paper addresses a general vision of the science of equity and sustainability, which could be called *ecosocionomics*. The conflict between economies, ecosystems, and social justice could be reconciled on a consensual platform constructed on the scientific basis. Concurring with Wilson's reasoning, it is argued in this paper that a proposed new platform of knowledge should confirm all the indisputable facts of all branches of science. We definitely reject any form of a win-win, or even win-win- win hypotheses. The three goals: economic efficiency, ecosystem protection, and social fairness are not compatible, they stand rather in opposition one to another . As far as human race occupies and reshapes the only World, there is no choice but to sit down and jointly solve our common problems. Mother Earth feeds humans generously, but only to certain limits of her carrying capacity , which cannot be exceeded. This paper represents a step in the ongoing process of looking for a way how to live within the natural limits, and the limits that were created by humans.

Key words: limits to growth, ecological economics, sustainability, equity, resilience, social metabolism, ethical trilemma

JEL: A12

1. Introduction

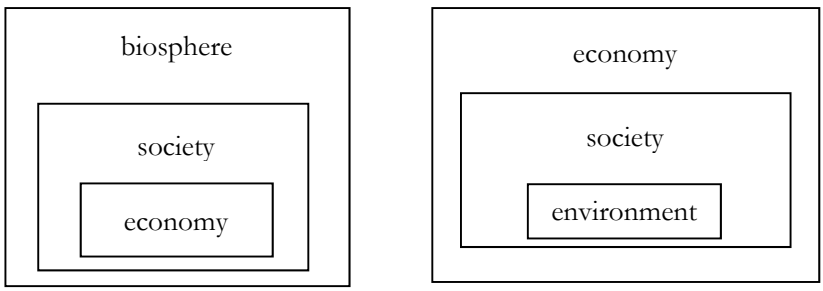
Entering the third millennium, humans find themselves overwhelmed by a number of problems unthinkable ever before. The greatest of them is the crisis of the planetary environment. The changes of global environment seriously and negatively affect almost all aspects of human existence.

Fortunately, nowadays there is a growing awareness of the causes of this tragic situation, as well as of the necessity of actions towards the stopping destructive processes. The first milestone in the direction of tracing the way out of impending doom was the report of the Club of Rome, entitled felicitously "The Limits to Growth". There are

indeed very serious physical and social limits to economic growth. The second significant step towards the saving our planet was undertaken by UN World Commission on Environmental Development (WCED). In the highly popularized Report of this Commission, "Our Common Future", there was the concept of sustainability. Since the time of publishing this Report in 1987, the term "sustainability" has gained the widespread recognition. This term, as well as many others, like "sustainable development", "sustainable teaching", or even "sustainable growth", or "sustainable consumption", rose to the prominence mantra.

Many discussions of sustainability invoke the principle of the three pillar model, called also the "three ring circus", because they concern the three systems: social, economical and environmental, and they are depictured by means of the three circuses, either mutually disjoint, or all intersecting . One should recognize however that the most fundamental is the natural environmental system: as a life-support system it is also referred to as biosphere. The biosphere is a self-regulating system, contrary to all artificial systems, which are created by humans and regulated by humans. All human-made systems are imbedded into the natural system and they are organized in forms of social institutions and organizations. For this reason human-made systems are called also social systems. One of the most important social constructs is the economy. The natural order of life and things is therefore the following: economy is embedded in the societal system, which in its term is embedded in its natural surroundings. Unfortunately, economists, especially those belonging to the neoclassical school and adhering the dogmas of economism, managed to reverse this eternal natural order of things putting it on its head, as shown in Figure 1.

FIGURE 1.
Natural order of things, and its reversion used by economists



Source: own drawing.

As a consequence, the three types of sustainability are considered: social, economical and environmental sustainability. For some, sustainable means that what lasts. For the others sustainability is related to the preservation of something. For example the

preservation of natural capital, or any capital, preservation of ability to meet the needs, preservation of consumption. Preservation of well-being is the most popular idea, particularly among the neoclassical economists. Historically, the concept of sustainability originated in the context of forests preservation. Later on, it was adopted by environmental movement. Lele called it "ecological sustainability" and defined as "the existence of the ecological conditions necessary to support human life at specified level of well-being through future generations" [Lele, 1991]. The concept of sustainability with fundamentally social connotation was defined by Barbier in 1987 as the ability to maintain desired social values, traditions, institutions, cultures, or other social characteristics" [Lele, 1991]. Quite differently the concept of social sustainability was defined by Chambers, who called it "sustainable livelihood", and defined as "a level of wealth and stocks and flows of food and cash which provide for physical and social well-being and security against becoming poorer" [see: Lele 1991]. Economists defined the sustainability through some quantities that they want to sustain perpetually. H. Daly has distinguished five such quantities: GDP, "utility", "throughput", natural capital, and the total capital, as the sum of natural and man-made capital [see: Daly, 2007] . For Daly himself, "sustainability can be defined in terms of throughput by determining the environment's capacity for supplying each raw resource and for absorbing the end waste products" [see: Daly, 2007].

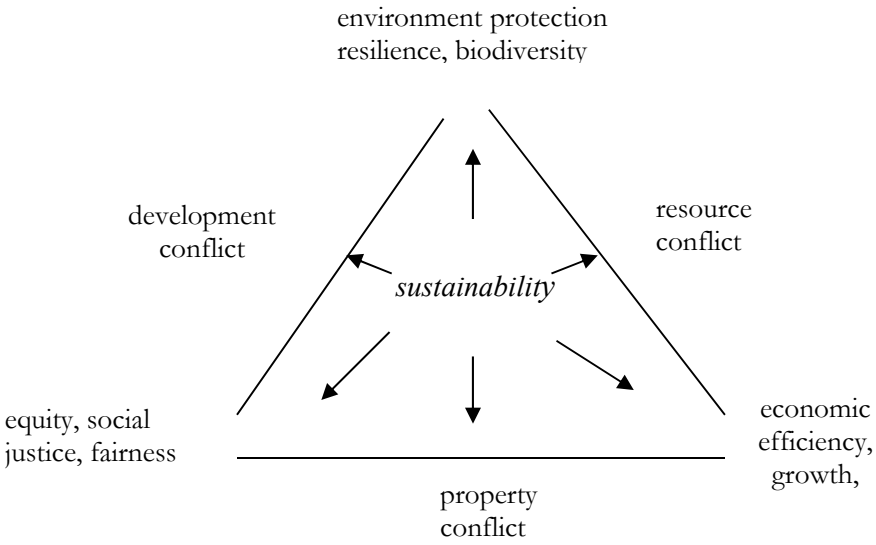
2. Ethical trilemma

From the previous paragraph it follows that for the three basic systems: natural, social, and economical, there are defined specific characteristics for sustainability. First of all, it is necessary to distinguish the three different types of human thought and behavior within these three domains. These three types of behavior are articulated in the form of the three models of *Homo: Homo economius, Homo communicus, and Homo naturalis* [see for example: Costanza, 2003]. There exist a vast literature concerning a wide characterization, as well as criticizing these models (see for example, Dequech, Lawson,). For that reason we limit ourselves to indicating merely the diverging systems of value, and rather conflicting goals. For the aim of expressing these goals as short as possible, they will be indicated by the expressions: Nature's vitality (or livelihood), social fairness, and economic efficiency. For the aim of this paper the most crucial is the notion of efficiency, which is conceived here in a sense of neo-classical economics, which is misguided by an attempt to put a price (monetary) on anything, which is even priceless, and which is founded on a Cost-Benefit analysis.

As we are living in One World, we need One goal: to sustain this world. In order to "integrate" these three goals one needs to reach a consensus on a shared value. The best way, if not the only, is the way described as "value formation through public discussion", which is attributed to A. Sen (see Costanza, 2003). For the ease of further exposition let us introduce three policy-makers, or sovereigns ruling in these three domains: biosphere, society, and economy. Let call them correspondingly *Bios, Socios,* and *Econ.* All the three of them have different goals. The first cares for a life, the second for healthy interpersonal

relations and the third one for increasing wealth, and profit. As is justly observed by Fuks, according to the mathematical, abstract game theory, there are games in which all players might end up with profits, but in the reality it is impossible [see: Fuks, 2012]. For our three players (agents), *Bios, Socios*, and *Econ*, there is no strategy win-win-win, so vividly, but irresponsibly advocated by corporate managers. Instead, they face the *trilemma*. This strange word, *trilemma,* was coined as an analog to the well known expression "moral dilemma", which refers to a situation in which an agent morally ought to do each of two acts, but cannot both. Trilemma refers to an analogous situation, when one has three goals, which cannot however be pursued simultaneously. The word was probably for the first time introduced in the report *Catastrophe or New Society? A Latin American World Model* [see: Erikson, 2010]. In this report a model was presented, known as the *Bariloche model*, in which the so-called global ethical trilemma is strongly emphasized. This means that the humankind pursued three goals: prosperity, justice, and biosphere vitality are not compatible. The economic efficiency is in an opposition to the ecosystem protection, but also to the social fairness. In a business oriented circles there is maintained the opposite opinion, and the so-called win-win ideology is promoted. Even in the highly publicized Brundtland Report one can find the assertion that "a new era of economic growth-growth that is forceful and at the same time socially and environmentally sustainable" [see: Ekins, 1993]. Such an attitude is rather highly unreasonable. Exactly for this reason there are appearing counter-reports. One them, not widely known, is the referred here Bariloche Report. Contrary to the Brandtland Report, authors of Bariloche Report focus on sociopolitical problems rather than on physical one. In this report the trilemma problem was fully recognized. The three mentioned above priorities (or goals) stand rather in opposite one to another. These three conflicting sets of priorities are usually depictured by means of triangle, as it is shown in Fig. 2. The idea of sustainability emerged as a way to the solution of this trilemma. Surveying existing approaches to sustainability, Lele arrived at the conclusion that sustainable development "is a 'metafix' that will unite everybody from the profit-minded industrialist and risk-minimizing subsistence farmer to the equity-seeking social worker, the pollution-concerned or wildlife-loving First Worlder, the growth-maximising policy-maker, the goal-oriented bureaucrat and, therefore the vote-counting politician" [see: Lele, 1991; Ekins, 1993]. The notion of sustainability is therefore placed somewhere in the center of the triangle shown in Fig. 2 .

FIGURE 2.
The triangle of conflicting goals with centrality of sustainability



Source: adaptation of [Campbell, 1996; Connelly, 1996; Eriksson, 2010].

The three disciplines concerning the three domains: social system, environmental system and economical system, represented by three corners of the triangle shown in Fig. 2, were developed in an isolation one from another. Moreover, the goals and the priorities of each of these disciplines stand in opposition one to another. Dilemmas , i.e. kinds of conflicts, are indicated on the edges of the triangle, (for a deeper account of them one can consult [Campbell, 1996; Connelly, 1996]. How deeply these disciplines are separated one can see from the methods or the models used by them. Illustrative examples of the typical models used in these three domains are shortly characterized in the next paragraph. Intentionally, any critical assessments are avoided. Only a short remark concerns the science of economy.

Economy, more precisely political economy, in Aristotelian meaning, as a moral science was very attractive for a long time. Pre-classical, and next classical economy was developing within a teleological framework, aimed chiefly at the good life.

Unfortunately, in the 20th century economics broke away from the real background and now is cultivated more as a mathematics than science concerning the real life. Moreover, the three big real problems: social ailment, economic polarization, and environment degradation, were caused by an ideology based on the profit and the economical prosperity. Contrary to economics, ecology is becoming now the most noble, comprehensive and diverse amongst sciences of life.

3. Economy system

The term economy is used to depict the processes of production and consumption. The body of a knowledge (science) describing, or prescribing, the ways how humans manage these processes is referred nowadays to as economics. Among many schools the one plays a privileged role, and it is the so-called neo-classical school. In its doctrine the economical system is reduced to the three processes: production, consumption and investment. The production function is usually taken as Cobb-Douglas function with constant returns to scale. This function is the following:

$$Y_t = K^{\alpha} R^{\beta},\ \alpha + \beta = 1 \tag{1}$$

where K stands for a human-made capital, and R for an exhaustible resource.

The output, Y_t, is taken for the consumption, x_t, and the investment, I_t. Sustainability is defined in terms of the consumption. More precisely, sustainability means consuming in the future not less than in the present. The possibility of such a sustainable consumption was proved by R. Solow. Namely, he showed that there exists a positive per capita consumption level that can be sustained forever, and this level is expressed by [Erreygers, 2009]:

$$x_0 = \left[\frac{S_o}{L_0}\right]^{\frac{\beta}{1-\beta}} \left[\frac{K_o}{L_0}\right]^{\frac{\alpha-\beta}{1-\beta}} (\alpha-\beta)^{\frac{\beta}{1-\beta}} (1-\beta) \tag{2}$$

where S_o is the stock of the resource available at time 0, K_o is the initial capital stock, and L_0 is the labor (constant population).

In accordance with the growth ideology , one obtains similar results within the framework of any other growth theory. In particular, within the so-called endogenous growth paradigm. The essence of this new wave is that the growth in the "old" neoclassical economics was accounted for by the capital accumulation, while now the growth is caused by innovations, i.e. by technological progress, which is supposed to be unlimited! In economical system there are considered now the three kinds of goods: the final good (*Y*) , the constant measure of specialized intermediate products (normalized to 1), and the labor (*L*). The final good is produced according to the following production function [Aghion, 2007]:

$$Y_t = \int_0^1 A_{it} L^{1-\alpha} x_{it}^{\alpha}\, di,\ \ 0 < \alpha < 1 \tag{3}$$

where x_{it} is the flow of intermediate input *i* used at *t*, A_{it} is a productive parameter of *i*, which is a measure of the quality of the input.

It is worth to note that the output is produced by a continuum of intermediate products (capitals).

A quite different approach to the "traditional" sustainability literature is an axiomatic approach offered by G. Chichilinsky [see for example: Pezzey, Toman, 2002]. Instead of focusing on consumption or capitals she based her proposal on the notion of utility. The utilitarian criterion in a general form is expressed as follows:

$$\frac{\boldsymbol{max}}{\text{feasible paths}} \left\{\sum_{\text{generation } t}^{\infty} utility_t\right\}$$

Assuming that the utility path (stream) of a person g will be denoted as a stream $\alpha = (\alpha_g), g = 1,2,\dots, \alpha_g = u_g(x_g), g = 1,2,\dots$, where $x = (x_g), g = 1,2,\dots$ is

a consumption path (stream). The above utilitarian criterion may be rewritten as follows

$$\frac{\boldsymbol{max}}{(\alpha_g)}\{\sum_{\text{generation } g}^{\infty} u_g(x_g)\} \quad (4)$$

Chichilinsky proposed the two specific axioms that any intertemporal welfare function should satisfy in order to be treated as a "sustainable preference" ordering. A welfare function which maps the utility stream to real numbers should satisfy the following axioms [Chichilinsky, 2009]:

1. W(.) should be able to rank any two feasible utility streams.
2. It should be able to give higher rank to a stream that Pareto dominates another stream.
3. It should satisfy "no dictatorship of the present". This means that the present generation should not dictate the outcome in disregard for the future. In other words, utility streams cannot be ranked taking into account only a finite number of initial generations.
4. It should satisfy "no dictatorship of the future". The future generations should not dictate the outcome in disregard for the present. In analogy to axiom 3, this axiom requires that streams of utilities cannot be ranked (evaluated) ignoring any number of initial generations.

Chichilinsky proves that intertemporal welfare function of a utility stream $\alpha = (\alpha_g), g = 1,2, \dots, \alpha_g = u_g(x_g), g = 1,2, \dots$ has the following form:

$$W(\alpha) = (1-\lambda)\sum_{g=1}^{\infty}\mu_g\alpha_g + \lambda\Phi(\alpha) \quad (5)$$

where $x = (x_g), g = 1,2, \dots$ is a consumption path (stream), and $1 > \lambda > 0$, $\sum_{g=1}^{\infty}\mu_g\alpha_g < \infty$, $\Phi(\alpha)$is a purely finitely additive measure on the utilities space.

4. Human system

By a human system we understand here any system consciously established by humans. Any human-made system is organized by humans in the form of various so-called social institutions and organizations. For this reason, the notion of social systems is used interchangeably with the notion of human systems. One of the most fundamental social systems is the society itself.

In all social sciences the basic problems are inequality and poverty. Usually the opposite concepts are considered: equality and welfare. Equality is the major "leitmotif" of the social science. In economics, the stress is put on the distribution of the resources, in political science more on the power, and in sociology on the social stratification [Esping-Andersen, 1990]. As far as economics is concerned, it is possible to measure both inequality and poverty in a unified way. The article by Barrett and Salles [Barrett, 1998] may serve as a good representative work in this strand, and our survey is based on it.

Suppose that F(y) denotes the distribution function of income Y, and that the $Y = \{(i, y_i): i \epsilon S\}$ is a distribution of income over a finite society S of size n>2. The axioms are following.

A1. Axiom1 (invariance). If distributions of income Y_1 and Y_2 over societies S_1 and S_2 have the same distributions functions, then $I(Y_1) = I(Y_2)$.

A2. Axiom 2. I(Y) is twice continuously differentiable with respect to individual incomes.

A3. Axiom3. $I(Y_e) = 0$, with $Y_e = \{(i, \bar{y}): i \epsilon S\}$ i.e. egalitarian distribution

A4. Axiom 4. (S-independence). There exist a function h such that a transfer of δ from *i* to *j* implies the "increase ", ΔI, the inequality expressed by $h(n, y_i, y_{j,}\delta)$.

A5. Axiom 5. (A-independence). As Axiom A4, but function $h(n, y_i, y_{j,}\delta)$ is substituted by $h(n, y_i - \bar{y}, y_j - \bar{y},\ \delta)$

A6. Axiom 6. (R-independence). As axiom A4, but function $h\left(n, y_i, y_{j,}\delta\right)$ is to be substituted by $h(n, \frac{y_i}{\bar{y}},\ \frac{y_j}{\bar{y}}, \delta)$

It is proved [see: Barrett, 1998] that if $I = I(Y)$ satisfies A1, A2, and A4, then there exists a continuous function $w = w(y)$ such that the increase ΔI is given by

$$\Delta I = n^{-1}\delta \int_{y_i}^{y_j} w(y)dy + o(\delta) \tag{6}$$

where $o(\delta)$ denotes a term whose ratio to δ tends to zero as $\delta \to \infty$.

The three classes (simple, absolute, and relative) of inequality indices are derived from these axioms, and they are distinguished by the last three axioms.

The *simple* inequality index satisfies Axioms 1, 2, 3 and 4, and is defined by the expression:

$$I(Y) = n^{-1} \sum_{i \epsilon S} \int_{\bar{y}}^{y_i} w(y)\ (y_i - y)dy \tag{7}$$

Absolute inequality index (satisfies A1., A2., A3., and A5.), and is defined by the same formula substituting y_i by $y_i - \bar{y}$.

Relative inequality index, satisfying A1., A2., A3., and A6., is defined in the same way: substituting y_i by $y_i/\bar{y}$.

If the weight function has the form $w(y) = ky^{-c}$, then relative inequality index defines the generalized entropy family of measures. Coefficient *c* captures the "inequality aversion" (more about this notion one can find in Ostasiewicz [2014].

The above simple inequality index is extended to *poverty measure*, by introducing a poverty line L, and by replacing $w(y)$ by $w(y, L)$.

The poverty measure is defined by the formula:

$$P(Y) = \ n^{-1} \sum_{y_i < L} \int_{L}^{y_i} w(y, L)(y_i - y)dy \tag{8}$$

One assumes that $w(y, L) > 0$, when $y < L$, and $w(y, L) = 0$, when $y \geq L$ [for details see: Barrett, 1998].

The other major theme of social science is the problem of democracy, in particular consensual bargaining though social interactions. In this field it is a lot to be done. One special domain is investigated very intensive. This is a problem of modeling discrete choices taking into account social interactions.

The most popular model amongst these families of models is the Brock-Durlauf model. It concerns the actions undertaken by a group of individuals. Suppose that a group consists of *N* individuals, their actions (decisions) denoted by *N*-tuple $\omega =$

$(\omega_1, \omega_2, \dots, \omega_N)$, with $\omega_i \epsilon \{-1,1\}$. One assumes that an act , or a decision, ω_i is treated as a realization of a random variable A_i. With each decision there is associated its utility [Brock 2001]:

$$U(\omega_i) = u_I(\omega_i) + u_G\left(\omega_i, \mu^e\ (\omega_{-i})\right) + \varepsilon(\omega_i) \tag{9}$$

where

$u_I(\omega_i)$ is an individual (private) utility associated with a choice and u_G is the group utility. $\omega_{-i} = (\omega_1, \dots, \omega_{i+1}, \omega_{i-1}, \dots, \omega_N)$ denotes the choices of all decision makers other than *i*, $\mu^e\ (\omega_{-i})$denotes the conditional probability measure that individual *i* places on the choices of others at the same time, $\varepsilon(\omega_i)$ is a random term .

It is assumed that

$$Prob(\varepsilon(-1) - \varepsilon(1) \le x) = (1 + \exp(-\beta x))^{-1} \tag{10}$$

$$u_I(\omega_i) = h\omega_i + k,$$

with

$$u_I(1) = h + k,$$

and

$$u_I(-1) = k - h. \tag{11}$$

$$u_G\left(\omega_i, \mu^e\ (\omega_{-i})\right) = J\omega_i \bar{m}_i^e \tag{12}$$

$$\bar{m}_i^e = \frac{1}{N-1}\sum_{i \ne j} m_{i,j}^e \tag{13}$$

where

$m_{i,j}^e$ denotes the subjective expected value (from the perspective of individual *i*) of individual *j* choice.

Providing these assumption one derives that $P(\omega_i) = P(A_i = \omega_i)$ is as follows:

$$P(\omega_i) = \frac{\exp(\beta(u_I(\omega_i) + J\omega_i \bar{m}_i^e))}{\sum_{\gamma_i \epsilon \{-1,1\}} \exp(\beta(u_I(\gamma_i) + J\gamma_i \bar{m}_i^e))} \tag{14}$$

Assuming the hypothesis of *rational expectations*:

$$m_{i,j}^e = E(\omega_j), \text{ for all } i \text{ and } j \tag{15}$$

one arrives at the following expected decision:

$$E(\omega_i) = tanh(\beta h + \beta J(N-1)^{-1} \sum_{j \ne i} E(\omega_j)) \tag{16}$$

The individual choices $\bar{m}_i^e$ in (12, 13), which are all equal to a common value, denoted by m^* and defined implicitly by the equation

$$m^* = \tanh(\beta h + \beta J m^*) \tag{17}$$

This value is called a stationary state, or expected average choice value, or self-consistence equilibrium.

It has been proved [Brock 2001] that there exists at least one self-consistent choice, and moreover, that when the size of the group tends to infinity, then

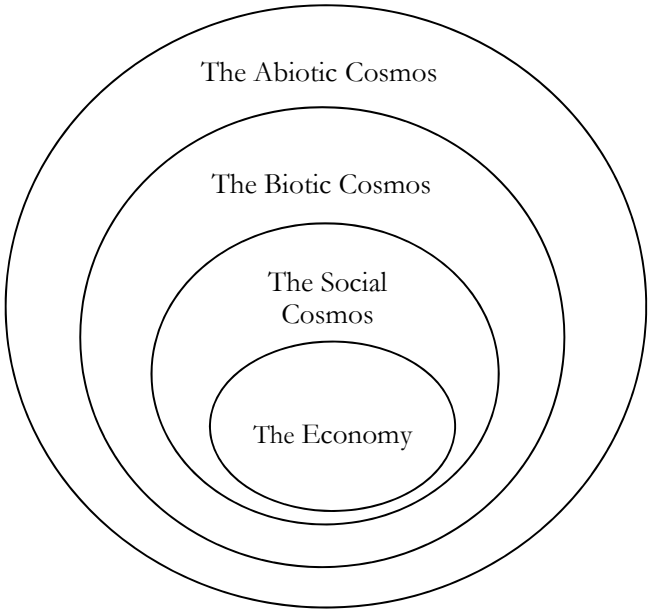
$$E(\omega_i) = \bar{m}. \tag{18}$$

In [Ostasiewicz, 2011] the Brock-Durlauf model has been significantly extended. Particularly by applying Holling's resilience measure.

5. Natura system

By the natural system we mean here the biosphere, that is, the living part of the Earth. This is the sphere of life. People, societies and the entire world created by the humanity are imbedded, or immerse, in the biosphere. Which in turn is a part of the abiotic cosmos, as it is shown in Figure 3.

FIGURE 3.
Matter and energy flows through the economic system



Source: [Fuks, 2012]

The science of biosphere, i.e. of the sphere of life and its environment, is known as ecology. The word "ecology" was invented by Ernst Haeckel (1834-1919), a German zoologist. With this term he defined a new science as the study of the interrelationships of organisms with their environment, as well as the relations between these organisms. Ecology is considered as the economy of nature. The term nature's economy introduced Linneaus in 1749 by publishing the book *Oeconomia Naturae*. Linnaeus defined this title as follows [see: Pearce]: "By the economy of nature we understand the all-wise disposition of the creator in relation to natural things, by which they are fitted to produce general ends, and reciprocal uses". The word "*oeconomia*" was used in Aristotelian meaning, namely, as a management of household. This usage was however metaphorically extended to both the macrocosm and the microcosm, i.e. to nature as a whole and to the human body [Pearce, 2010]. At the very simplest, the economy involves two processes: production and

consumption. The main producers of organic matter are the following: forest, woodland, cultivated land and marine. The main consumers are all living organisms, classified into five kingdoms. The Earth itself, at least within the framework of the so-called deep ecology, is considered as a total self-organizing and self-reproducing organic system, having the goal to maintain itself. In spite of being one of the youngest branches of science, ecology is now the most comprehensive and most important science about the life on Earth considered as an abode for any living organisms, including humanity. As an illustrative example of the quality of models used by ecologists could serve the model which concerns a food web structure. It is the well-known Cropp-Gabric three-compartment food web model [Kristensen, 2003]:

$$\frac{dP}{dt} = \mu_P P\left(\frac{N}{N+k_P}\right) - e_Z PZ \tag{19}$$

$$\frac{dZ}{dt} = e_Z(1-\eta_Z)PZ - d_Z Z \tag{20}$$

$$\frac{dN}{dt} = d_Z Z + e_Z \eta_Z PZ - \mu_P P\left(\frac{N}{N+k_P}\right) \tag{21}$$

where

P, Z, and N are Phytoplankton, Zooplankton, and Nutrient, correspondingly;

e_Z is the consumption per day of phytoplankton mass per zooplankton mass;

μ_P is the maximum phytoplankton nutrient uptake rate;

k_P is the nutrient half saturation concentration for phytoplankton;

d_Z is the zooplankton mortality;

η_Z is the efficiency of zooplankton conversion of nutrient into biomass.

The other model is a model of grazing pressure [see: Brännström, 2012]:

$$\frac{dX}{dt} = rX\left(1-\frac{X}{K}\right) - c\frac{X^p}{X^p+H^p} \tag{22}$$

K denotes carrying capacity, *c*-maximum grazing rate, *H* – grazing population (herbivores), *X* – nutrient, and *p* is a parameter. An excellent review of models used in the ecology is given in [Brännström, 2012].

6. Towards of consilience

At least officially, since 1987 we started to think about our common future. As "we are now one world" [see highly recommended book: Singer, 2004], our common future depends only on us, on our common efforts, and our common will to save the planet for our grandchildren. The only problem is our vision of this future, and next, what we should do in order to guarantee the chosen vision?

First of all we must construct (define) shared vision of a sustainable and desirable world. One of the most interesting and promising approaches is "The 2050 Project", initiated in 1993 by the World Research Institute, the Brookings Institutions, and the Santa Fe Institute. "Choosing Our Future" as a shared vision of a sustainable world "grows out of an attempt to find what people in developing countries hope the world will be like in the next century" [Nagpal, 1995]. Aspiring to construct a shared vision of the world, one must remember that all people see life through their own, usually diverse,

prisms. As it is well known that the whole is not just the sum of its parts, it is something over, i.e. above its parts. . In the case considered here, these "parts" constitute three domains, which were used to be called three pillars of sustainable development. These three domains were presented graphically by the three vertices of the triangle shown in Fig. 2. In order to design an integrated and consilient interdisciplinary science of sustainability one needs to rise above particular interests of these three domains: Biosphere (ecosystem), Economy, and Society. The point of "a leaping together", meaning a "consilience", is represented graphically in the Figure 4 as the vertex of the tetrahedron build on the triangle whose vertices represent the three appropriate domains . The edges of this triangle symbolize the disciplines which intend to link two adjacent domains: ecology and economics, sociality and economics, sociality and ecology.

The vertex of tetrahedron might be thought of as the collaborative platform, or platform of the so-called "democratic struggle" of the three sovereigns: *Bios, Socios, and Econ.*

In order to join forces under a common banner, say, sustainability, one must recognize and admit that the magnitude and the impact of human activity, chiefly economic activity, have become a powerful force modifying the biosphere in a way that the whole life on the Earth is threatened.

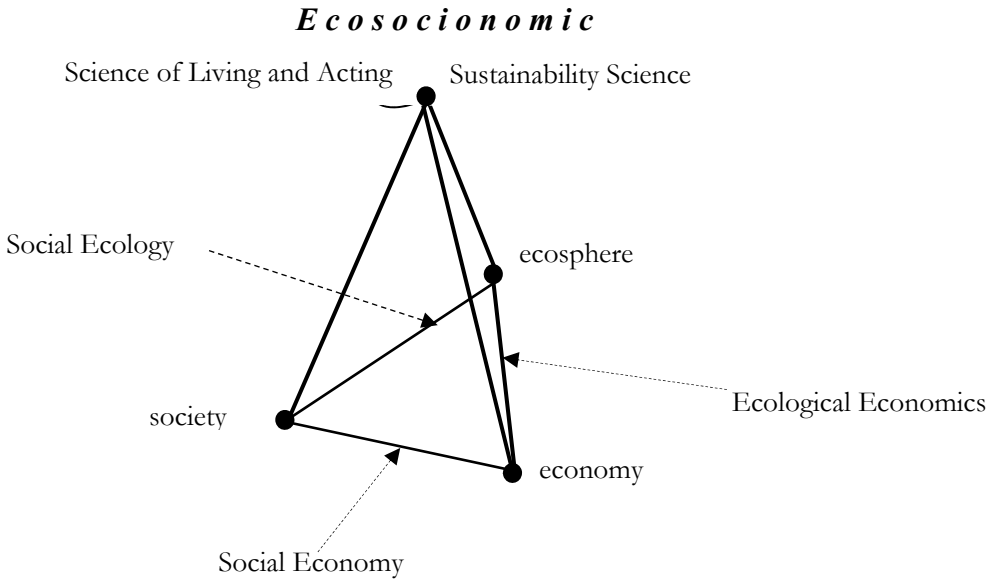
The consilience between economics, ecology, and social science can be feasible only when three basic prerequisites are fulfilled.

The first of them is expressed as follows. Humanity organized in a form of societies must recognize the nature's superiority, and to give up a dream of domination over nature. The Earth is the abode for all living organisms. Every living creature on the Earth has a right to live, be it a single-celled algae, or a very complex, multi-celled *homo sapiens. Homo sapiens'* credo should be therefore the following: I am a life that wants to live, in the midst of life that wants to live (in original German language, Schweitzer expressed it in the following beautiful sentence: *Ich bin Leben, das leben will, inmmitten von Leben, das leben will*). This general principle could be supplemented by particular commandments, like these proposed by Georgescu-Roegen (see [Gowdy 1998]): *Thou shalt love thy species as thyself*, *Thou shalt minimize regrets instead of maximizing thy utility*.

The second prerequisite concerns society. Society, as an integral part of the nature, as its natural entity, is to be treated in the same way as the entire nature. This means that the society must be treated as a true living body, the highest manifestation of the process of organic evolution [Padovan, 2000]. The subtitle of the first volume of the treatise published in 1873 by Paul von Lilienfeld (1829-1903) in 1873 is the following: *Die menschliche Geselschaft als realer Organismus* (the human society as the real organism). In Paul Lilienfeld opinion, the only difference between a biological organism and a social organism is that a social one is less integrated than a biological one. He said that *Nihil est in societate quad non prius fuerit in natura* (more information about this issue contains interesting paper by [Padovan, 2000]).

FIGURE 4.

Tetrahedron of ecosocionomics



Source: own drawing

The third prerequisite concerns social arrangements and institutions. All social institutions and organizations are artifacts designed by people to serve them. This assertion concerns particularly the economy. The economy is not a natural entity, it is a human-created entity, created to serve humans. The economy is founded on the natural resources, therefore, it is part of the ecology. Moreover, the economy is embedded in social institutions.

The basic economic processes are not these of production and consumption. The father of the neoclassical economics, A. Marshall, reminded us that man cannot create material things, his production of material products is really nothing more than a rearrangement of a matter which gives it new utilities. His consumption is also nothing more than a disarrangement of a matter which destroys its utilities (see many interesting writings by [Daly, 2007]. From this follows that in an opposition to the mechanistic view, the economy and its processes should be considered from the entropic perspective. Moreover, such a perspective implies an organismic interpretation of economic processes [see: Ostasiewicz, 2016].

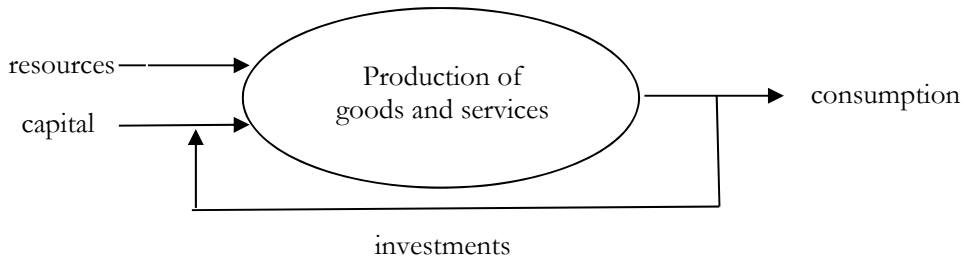
7. Conclusions

While sustainability initiatives, movements and serious academic researches continue to grow and spread, there is also a formidable opposition. After appearing the fundamental works about the limits of growth (physical, social, and even ethical), some scientists immediately tried to discredit these works. Particularly pitiful are those who are doing this for money, "merchants of doubts". Very dangerous is the opposition of the established industrial-commercial-banking complexes and their allies. There are some others serious threats pointed on by H. Daly who observed that establishing and maintaining sustainable development required an enormous change of minds and hearts by economists, scientists, and politicians. The latter are of particular importance. A good example was given by "a former Hollywood gunslinger" who took charge of the Oval Office: the lively social indicators movement was stopped then, the budget of the EPA was slashed by almost 60 percent, the scientists who refused to downplay an environmental data damning of the industry were fired [Mitman, 2006]. It is therefore a good reason to think about a "political impossibility" of the sustainable development. However, one should agree with H. Daly's assertion: "In choosing between tackling a political impossibility and a biophysical impossibility, I would judge the latter to be the more impossible and to take my chances with the former" [Daly, 2005]. Al Gore nicely backed such a decision observing that a political will is a renewable resource.

Besides a political will, scientific unification requires an essential reshaping many of existing scientific disciplines. Above all, economics has to be altered. Simple, but essential neoclassical model of production, accumulation, and consumption is presented in Figure 5.

FIGURE 5.

Neoclassical economy model

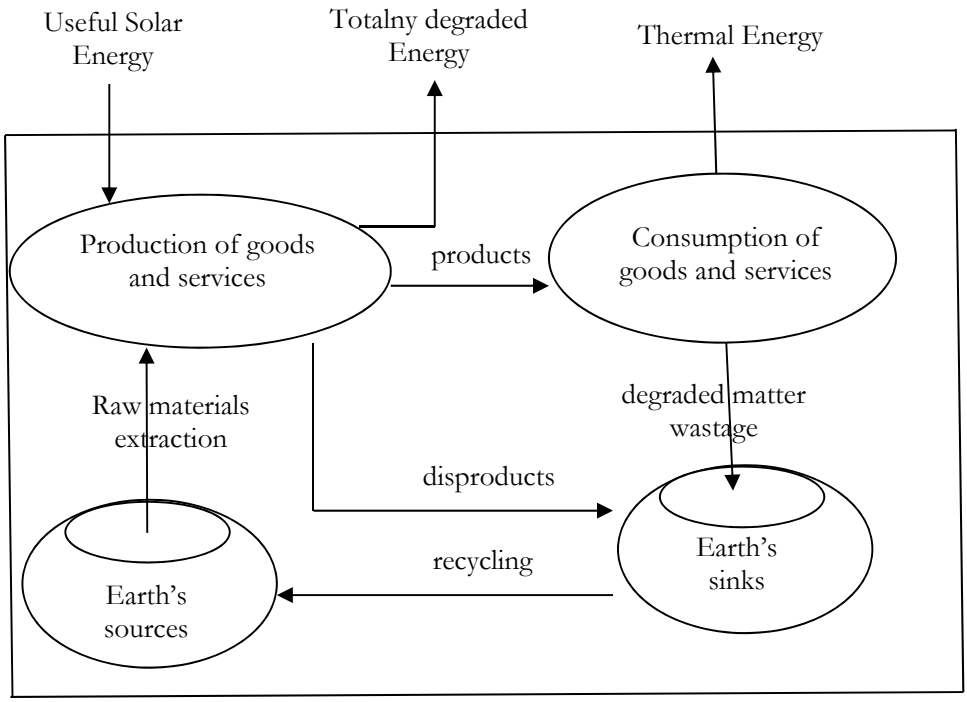


Source: own drawing.

Model presented in Fig. 5 ignores the existence of "the limits of growth". Two kinds of physical limits, should be included in a model: limited resources, and limited capacity of sinks to absorb the wastages. The impossibility of Nature to absorb the increasing amount of waste generated within the economy system is considered even more important than scarcity of resources. For this reason, this unrealistic model should be substituted with an "ecological" one of the type presented in Figure 6.

FIGURE 6.

Matter and energy flows through economic system



Source: [Fuks, 2012], with minor modification.

It seems to be very reasonable to argue that consilience can be reached by accepting philosophical and methodological holism. Social institutions should be considered as wholes, irreducible to the individual. This means that Hegelian social philosophy seems to be more appropriate than Popperian individualism.

Acknowlegement

This paper is based on our presentation at the AMSE Conference [see: Ostasiewicz, 2014 for the proceedings of this Conference]. We would like to thank Prof. R. Zimka for his critical remarks, we are also grateful for one anonymous referee for his (her) highly valuable remarks improving the present paper, and being good inspirations for further and deeper study.

The authors' participation in the preparation of the article

dr inż. Katarzyna Ostasiewicz – the part of technical and value-neutral presentation of the prevailing, formalized forms of the scientific treatment of the three main domains concerning sustainability – 75%

prof. dr hab. Walenty Ostasiewicz – the whole valuating and ideological matters – 25%

Bibliography

Aghion., Howitt P., 2007, *Capital, Innovation, and Growth Accounting*, "Oxford Review of Economic Policy", Vol. 23, 79-93.

Barret R., Salles M., 1998, *On three Classes of Differentiable Inequality Measures*, "International Economic Review", Vol. 39, 611-621.

Bonevac D., 2008, *Is Sustainability Sustainable?*, "Acad Quest", 23, 84-101.

Branstrom A., Johansson J., Loeuille N., Kristensen N., Troost T. A., Lambers R. H., Dieckmann U., 2012, *Modelling the Ecology and Evolution of Communities: A Review of Past Achievements, Current efforts, and Future Promises*, "Evolutionary Ecology Research", 14, 601-625.

Brock W. A., Durlauf S. N., 2001, *Discrete Choice with Social Interactions*, "Review of Economic Studies", 68, 235-260.

Burnst T. R., 2012, *The Sustainability Revolution: A Societal Paradigm Shift*, "Sustainability", 4, 1118-1134.

Campbell S., 1996, *Green Cities, Growing Cities, Just Cities*?, "Urban Planning and the Contradictions of Sustainable Development. Journal of the American Planning Association", 62(3), 296-312.

Chichilinsky G., 2009, *Avoiding Extinction: Equal Treatment of the Present and the Future*, Economics, Vol. 3, 1-25, www.economics-ejournal.org (accessed 30.04.2016).

Conelly S. 2007, *Mapping Sustainable Development as a Contested Concept*, "Local Environment", Vol. 12, No. 3, 259-278.

Costanza R., 2003, *A Vision of the Future of Science: Reinterpreting the Study of Humans and the Rest of Nature*, "Futures", 35, 651-671.

Costanza R., 2003, *Social Goals and the Valuation of Natural Capital,* "Environmental Monitoring and Assessment", 86, 19-28.

Daly H., 1968, *On Economics as a Life Science*, "Journal of Political Economy", Vol. 3, No. 3, 392-406.

Daly H., 2005*, Economics in a Full World,* "Scientific American", September.

Daly H., 2007, *Ecological Economics and Sustainable Development. Selected essays of Herman Daly*, Edward Elgar.

Dequech D., 2007, *Neoclassical, Mainstream, Orthodox, and Heterodox Economics*, Vol. 30. No. 2, 279-302.

Ekins P., 1993, *'Limits to Growth' and 'Sustainable Development': Grappling with Ecological Realities,* "Ecological Economics", 8, 269-288.

Erikson R., Andersson J. O., 2010, *Elements of Ecological Economics*, Routledge.

Erreygers G., 2009, *Hotelling, Rawls, Solow: How Exhaustible Resources Came to Be Integrated into the Neoclassical Growth Model,* "History of Political Economy", 41, 264-282.

Esping-Andersen G., 1990, *Social Foundations of Post-Industrial Economics*, Oxford University Press.

Figuieres Ch., Tidball M., 2012, *Sustainable Exploitation of a Natural Resource: A Satisfying use of Chichilinsky's Criterion*, "Econ Theory", 49243-265.

Fuks M., 2012, *Reflections on the Paradigm of Ecological Economics for Environmental Management*, "Estudos Avancados", 26(74), 105-118.

Gowdy J., Mesner S., 1998, *The Evolution of Georgescu-Roegen's Bioeconomics*, "Review of Social Ecology", 2, 137-156.

Kristensen N. P., Gabric A., Bradock R., Cropp R., 2003, *Is Maximizing Resilience Compatible with Established Ecological Goal Function?,* "Ecological Modelling", 169, 61-71.

Lawson T., 2005, *The Nature of Heterodox Economics*, "Cambridge Journal of Economics", 8, 1-23.

Lele S., 1991, *Sustainable Development: A Critical Review*, "World Development", 19(6), 607-621.

Mebratu D., 1998, *Sustainability and Sustainable Development: Historical and Conceptual Review*, "Environ Impact Asses Rev", 18, 493-520.

Mitman G., 2006, *Where Ecology, Nature, and Politics Meet: Reclaiming The Death of Nature*, "Isis", 97, 496-504.

Nagpal T., Foltz Ch., 1995, *Choosing our Future. Vision of a Sustainable World*, World Research Institute.

Ostasiewicz K., 2014, *Impact of Outliers on Inequality Measures- A Comparison between Polish Voivodships*, "Silesian Statistical Review", 12(18), 105-120.

Ostasiewicz K., Magnuszewski P., 2011, *The Concept of Resilience and its Application to a Certain Socio-Econimical Model*, "Pragmata Tes Oikonomias", No. IV, 203-216.

Ostasiewicz W., 2016, *Metabometria,* "Śląski Przegląd Statystyczny", 14(20), 145-183.

Ostasiewicz K., Ostasiewicz W., 2014,*Towards the Science of Equity and Sustainability,* http://www.amse.ue.wroc.pl/proceedings.html (accessed: 30.04.2016).

Padovan D., 2000, *The Concept of Social Metabolizm in Classical Sociology,* "Revista Theomai", No 2, http://www.redalyc.org/articulo.oa?id=12400203 (accessed: 30.04.2016).

Pearce T., 2010, *"A great Complication of Circumstances" – Darwin and the economy of nature,* "Journal of the History of Biology", 43, 493-528.

Pezzey J. C. V., Toman M. A., 2002, *The Economics of Sustainability: A Review of Journal Articles*, Discussion Paper 02-03, RESOURCES for the Future, http:// www.rff.org (accessed: 30.04.2016).

Singer P., 2004, *One World, the Ethics of Globalization*, Nota Bene, Yale.

Soderbaum P., 2014*, The Role of Economics and Democracy in Institutional Change for Sustainability,* Sustainability , 6, 2755- 2765.

Wilson E. O. 1998, *Consilience: the Unity of Knowledge*, Knopf, New York.