Andrzej GRACZYK
Wrocław University of Economics, Poland
Zbigniew JAKUBCZYK
Wrocław University of Economics / Opole University, Poland
Romuald JOŃCZY
Opole University, Poland

ECOLOGICAL BARRIERS TO DEVELOPMENT – A LOCAL PERSPECTIVE

1. Sources and Sinks

The existence of human society is dependent on the constant use of air, water, food, raw materials and sources of energy from the Earth and its atmosphere. This leads to the constant pollution of the Earth by waste and pollutants. The limits of economic development are determined by the capacity of the Earth's sources[1] of the required streams of materials and energy and the capacity of the Earth's sinks[2] to absorb waste and pollution [Meadows and Randers, 1972, 40].

The use of any type of resource by human society, regardless of whether it is food, timber, oil, iron, or any other resource, is constrained both by its sources and sinks. The nature of these constraints is highly complex, since these sources and sinks form part of a dynamic, interconnected whole: the Earth. Some constraints are much clearer than others. There are both short-term and long-term constraints. The fact that in general these sources and sinks interact with each other is crucial. An element of the natural environment can play the role of both source and

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[1] The term source of streams of materials and energy used by a system has been used, for example, by: Meadows et al. [1972]

[2] The final destination of streams of materials and energy used by a system, in this article taken to be the world economy.

sink. In this case, its capacity to play one of these roles depends on the degree to which it plays the other role [King and Schneider, 1984].

2. Dimensions of Ecological Barriers

It is accepted that ecological barriers to economic growth have two basic dimensions: barriers of limits on resources and barriers caused by the degradation of the natural environment.

The idea of *safe limits* introduced by H. Daly seems to be a theoretically optimal approach to the problem of limited resources. In the case of renewable resources – *e.g.* land, water, timber and fish – the long-term safe rate of consumption cannot exceed the rate of regeneration.

In the case of new-renewable resources – fossil fuels, metals, underground water supplies – the rational rate of use cannot be so high as to prevent the independent regeneration of a resource. For example in the case of crude oil this should be understood in the following way: crude oil deposits should be exploited in such a way that a proportion of the income obtained from oil drilling should be used to invest in research on renewable forms of energy. This proportion should be high enough to ensure that when oil deposits run out, it will be possible to obtain the same supply of energy from renewable forms of energy [Daly, 1990].

It should be noticed that no model of economic growth has yet taken into account the rate of the regeneration of resources as a factor. This is due to the fact that mankind basically did not feel that the rate of the regeneration of resources could limit economic growth. Forecasts of economic development have always treated this problem in the following way: a growth rate was assumed and the increase in the demand for raw materials was simply subject to this growth rate. There have been no attempts to solve this problem from the opposite point of view *i.e.* given the degree of regeneration of natural resources, what rate of growth can we obtain? The difficulty in such an approach, as in the approach of H. Daly to define *safe limits*, lies in the fact that it would be necessary to quantify the rate of regeneration in the model.

It follows from these arguments that the concept of barriers of limited resources on economic growth cannot be specified in a mathematical form, since defining such barriers in terms of time or as numbers cannot help us to predict the technologies and methods that will be in use in the field of energy supply and raw materials in a few years time. Apart from this, non-renewable resources may be substituted by other resources. Finally, the entire process of resource use is subject to increasing costs of their extraction due to their dwindling deposits, which leads to an increase in the price of these materials.

H. Daly defines the moment of crossing the *safe limit*, understood as the barrier of environmental degradation, as the moment when the permitted rate of emissions first exceeds the rate at which such pollution can be processed, absorbed or rendered harmless by the environment (*e.g.* emitting sewage into rivers or lakes does not cause any threats until emissions exceed the level which a given aquatic system is in a state to neutralise [Daly, 1990]). Such a limit would also be extremely difficult to formulate in economic terms.

In neo-classic economics environmental pollution is an ecological barrier to economic growth when it results in a lower standard of living for the population in the following sense: the increase in living standards caused by an increase in the consumption of goods and services (including non-material services) does not compensate for the fall in living standards resulting from the deteriorating state of the environment [See Fiedor, 1991, 28].[3] Despite the acceptance of this definition by many economists, this concept is also extremely difficult to formalise in quantitative terms. This results from the fact that the category of constrained development or economic development does not regard just the problems of depletion of natural resources and pollution, but also the degradation of ecological conditions resulting from economic growth, understood from a wide perspective. B. Fiedor states that the concept of constraints has at least three dimensions related to:

1) constraints of basic natural resources and sources of energy essential to the process of sustained economic growth;

2) constraints on the basic components of the environment, which define its quality; constraints on air, surface and underground waters, living space. This should be understood in terms of quality and not quantity. The quality of these components depends on both the level of pollutants and the capability of an ecosystem to regenerate itself.

3) constraints on ecological conditions. Such constraints, understood as the constantly worsening state of the quality of given components of the environment, influence not only the course and effectiveness of management processes, but also the social and economic spheres. This is connected with the need (demand) for such a "supergood" as a clean environment. This regards the capacity of various elements of the natural environment to satisfy needs of a psychological, aesthetic and recreational nature (culturally determined needs [Czaja et al., 1993, 46]).

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[3] This is a definition of barriers to economic development in agreement with the concept of a Pareto optimum, which is a basis of the analysis of the functioning of an economy using neo-classical ideas of equilibrium and sustainable economic growth.

From a wider perspective, environmental pollution as a barrier to economic development can take one of three dimensions depending on whether it relates to the social, economic or ecological system.

The **social barrier** is reached when the level of emissions of pollutants at the scale of the area investigated (country, region, ecologically threatened area) is high enough to negatively affect people's health, the climate, flora and fauna, the soil, air and water [Fiedor, 1991, 28].

The **economic barrier** is reached when the increasing level of pollution prevents, or significantly hampers, continued economic growth, due to a general fall in the effectiveness of an economy [Fiedor, 1991, 29].

The **ecological barrier** can be defined according to H. Daly's concept described above [Daly, 1990, 2 ff.].

These dimensions are not independent of each other, even the ecological and social dimensions. For example, if the health of the population worsens due to environmental pollution, then in the long-term this will have significant economic impact. Similarly, the state of certain components of the environment affects not only the physical and psychological health of the population, but also the costs of providing various goods and services. A classic example of this is accelerated wear of machines, devices and buildings, leading to rapid de-capitalisation of capital goods.

It should also be stated that, as in the case of barriers of limited resources, in the case of pollution we cannot talk about any quantitative measure of such ecological barriers to socio-economic development.

3. The quantification of barriers

However, it is not only the multidimensionality of ecological barriers that causes any attempt at describing potential barriers to economic growth in dynamic models to be imprecise. This also results from a series of other factors, among which the following are the most important:

1. The existence of a large number of interrelated factors, through which the environment influences development and/or economic growth.

2. The difficulty of quantifying these factors. This is related to the effect of the environment on the standard of living. A quantitative appraisal of such a factor seems to be practically impossible when we take into account the fact that it is not only dependent on the material quality of life of a given society, *i.e.* the willingness to pay for a given quality of the state of the environment. This state does not depend exclusively on the behaviour of a given society, because the environment may be polluted by neighbouring societies. In such a case, it is necessary to induce the neighbouring society to reduce the level of pollution emis-

sions, since the neighbouring society is likely to wish to increase its income and as a result increase the level of emissions.

3. The variation of such factors over time. The following factors are variable: population size, the supplies of renewable resources, to a certain degree the supplies of non-renewable resources (for example, new deposits of a material may be found).

4. Variation in the economic use of resources. This regards the possibility that various materials and elements can become resources. For example, the possibility of obtaining energy from titanium has meant that titanium has become a resource. In addition, some forms of waste are now treated as resources and it is likely that many forms of waste will become resources in the near future.

5. Unpredictability regarding what new ecological constraints may arise or become noticeable in the future and what the effect of today's actions in the future will be, since there are time lags in natural processes. For example the influence of pollution on the ozone layer was only discovered in 1974 and the hole in the ozone layer in 1984. This indicates that the negative effects of human activities on the environment only become visible after a long period of time and such effects may be discovered in the future when they are already in an advanced state.

6. The unpredictability of predicting the rate and directions of technological advance even in the short-term.

4. Global and local barriers to development

Overcoming ecological barriers to economic growth demands, among other things, an answer to the question of which ecological problems should be solved at the individual levels of government – local, regional, national or inter-regional or global.

Since this question is connected with the division of responsibility between different levels of government: local, national and international, it is necessary to consider the criteria which decide whether a barrier, either of limited resources or of ecological degradation, is of a local or global nature.

5. The criterion of the "regionality" of barriers of limited resources

With respect to barriers of limited resources which hamper development, a distinction can be made between "regional" and "global" barriers, depending on the importance of natural resources to the economy and society.

In practice, when a resource is in shortage in a certain region, it may be supplied from other regions, or substitutes may be used, if they exist. With respect to supplying resources from other regions, the largest burden on a local society is caused by a shortage of those resources that are the most costly to transport from outside the region.[4] Using transport costs as a criterion, the greater the use of a good (the volume of that good used) which is in shortage in that region, the more "regional" the character of this barrier to development. This implies that the cheapest goods which are used in large amounts, such as water or, to a lesser extent, wood and basic raw materials for construction, are the most "regional". The transport costs of these resources may be very high, and in the extreme case of large shortages it may be senseless to develop a certain area (for example, it is difficult to imagine supplying water from Siberia to the Sahara).

The availability of resources necessary for human development, which are often the cheapest and generally accessible (see Figure 1), is a decisive factor determining the basic means of existence of a society and

	The importance of a resource for the human existence		
(Basic resources)	High	Low	(Basic resources)
Low	Air		Wide-spread
	Water		
	Soil		
	Firewood		
	Coal		
Price of resource	Iron ore		Accessibility of resource
	Crude oil		
	Natural gas		
	Gold		
	Platinum		
High	Diamonds		Limited
(Resource of a higher order)	Low	High	
	The importance od a resource for the direction of economic development		

Fig. 1. The role and importance of natural resources for regions
Source: Author's own elaboration.

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[4] Exhaustion of the resource on a global scale is not taken into consideration here.

whether settlement will occur in a certain area. However, this factor has a limited influence on the direction of development of that area.

As is shown in Figure 1, the resources that are generally accessible (*e.g.* air and water) determine whether human existence and settlement are possible in a region. Scarce resources, which are more expensive and less accessible, more strongly determine the speed and direction of regional development.

Analysing Figure 1, it can be concluded that the more indispensable a resource for human existence, the more important it is for a region and the more noticeable a barrier that results from its shortage. The possession of more expensive resources, which are less accessible, facilitate rapid economic development. At the same time, a lack of such resources does not have such negative consequences for the economy as a lack of, for example, water, as low transport costs makes it possible to supply them from outside the region.

In practice a certain type of feedback can be seen in these dependencies. This has its roots in international and interregional trade. The existence of trade means that regions with an abundance of "resources of a higher order", obtaining high incomes from their exploitation (or from other activities), have more opportunities to overcome development barriers, in the form of a lack of or exhaustion of "basic resources", by buying them from other regions.[5] This is visible in Arabic countries, where oil revenues can be invested in irrigation systems and equipment for desalinating sea water.[6]

Thus, a lack of „basic resources" creates a stronger barrier to development than a lack of „resources of a higher order". At the same time the role of "basic resources" in the development of a region is limited. "Resources of a higher order" influence economic development more strongly, although the lack of such resources does not influence the economy as much as a lack of "basic resources".

6. The criterion of the "regionality" of barriers of environmental degradation

As in the case of natural resources, it is also difficult to clearly establish which types of pollution have a regional character. However, from

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[5] For example, the Netherlands can breed much more cattle than would be possible under the natural conditions existing there by importing fodder from Third World Countries.

[6] A more extreme example of this would be a tourist region possessing beautiful and clean nature, which buys resources in shortage from neighbouring regions.

the point of view of global energy flows, which is required when using the concept of sustainable development, all types of pollution negatively influence the global economy as a whole.

Whether pollution is defined as regional or global depends on the number of direct victims of environmental problems. The larger the number of direct victims (or the larger the area harmed) of a certain type of environmental degradation and the larger the indirect effects in the long run, the more global the pollution. This is connected with the chemical instability of pollution and how fast the pollution spreads over a larger area (see Figure 2).

Territorial range of environmental pollution

	Local	Global
Large		Greenhouse effect
		Hole in the ozonelayer
Diffusion of pollution (Number of victims of pollution)		CO2 emission
		Gas pollution
		Pollution of large water reservoirs and rivers
	Dust pollution	
	Pollution of streams	
	Pollution of small water reservoirs	
	Dangerous waste	
	Industrial waste	
Small	Communal waste	

Fig. 2. The character of (direct) territorial range of environmental pollution.
Source: Author's own elaboration.

Whether pollution is regional or global is strongly connected with the physical state of pollution. Solid substances tend to cause pollution on a local scale, and people living in this area suffer the most from its effects. Pollution of, for example, large water reservoirs by sewage is a threat to larger areas.

Pollution by gases which easily spread through the air endangers the largest areas. The diffusion of many gases means that they are spread throughout the Earth's atmosphere. The interregional and sometimes global nature (*e.g.* the hole in the ozone layer, greenhouse effect) of pollution creates the necessity of global control, where environmental costs and material flows have to be taken into consideration on a global scale.

Using the criteria developed above, the most local ecological barriers to regional development are:

– pollution by industrial and communal waste,
– pollution of small reservoirs and streams,
– dust pollution,
– a lack of and bad quality of water resources,
– a lack of and low quality of basic construction materials,
– a lack of and low quality of forest resources,
– a lack of and low quality of soil.

7. Practical ways of overcoming barriers in the local sphere

The need for the ecological balancing of the economic process demands greater insight and care regarding the management of natural resources. The rate of the process of ecologisation development at local level will depend on all of the following: local government, enterprises and households. The role of each group will vary.

Local government should play a key role in this process. In particular, this is related to the need for environmental protection in the context of social consumption, understood in its broad meaning [See Różańska, 1989, 63–64], with particular stress being placed on the quality of the environment where people live. Consumption, understood in its broad meaning does not influence just subjective factors of economic growth. It is clear that devastation of the natural environment, in general due to pollution, has a negative influence on forestry and agricultural production. It also reduces the efficiency of industry and the quality of services. The quality of life and state of health of populations inhabiting areas with a large heavy industry and energy production sector are also negatively influenced and this results in lower productivity. In such a case, the functions of an environmental protection policy are strongly linked to the problem of reducing energy consumption, which is crucial in developed countries. Saving energy is, at present, equivalent to reducing environmental pollution (air pollution, above all), preserving natural resources and areas of natural beauty. These are the factors that directly shape the quality of the environment, especially the local environment.

One role of the state and local government is to influence economic life in a region. It is clear that this cannot take place in the form of direct activity in the work processes of individual firms, but in a more indirect way – by defining priorities and frameworks in which these processes can take place and financially supporting favoured forms of develop-

ment. This requires discussion regarding the best economic structure of a region and the perspectives for sustained economic growth. In the face of public expectations zero growth does not make any sense. There should, however, be discussions regarding the quality of various forms of growth. What is growing? Who pays the costs of such growth? Who benefits? Is growth sustainable?

In practice the ecologisation and rationalisation of the process of regional development requires the introduction of various instruments enabling an economy to evolve from its present state to a desired state. The following question remains: how can the desired state be concretely described at an economic level?

The population must also satisfy its needs, which vary according to average earnings. The following question should also be asked – are these needs realistic in the light of ecological barriers and are these needs satisfied in the simplest way possible? We should also ask the following question – to what degree is satisfying these needs detrimental to the environment?

The activities of local governments, enterprises and households can achieve a great deal to support ecologically aware development at local and regional level. Some of these activities are simultaneously economically beneficial (so called win – win solutions), for example insulating homes (energy saving), using ecologically friendly fuels (reducing the emission of dust and gases), the sorting and reuse of waste (recycling) and extending the period of use of products which use a large amount of materials. Such methods should thus be generally implemented.

There are ideas that show that it is possible to increase the quality of life, while at the same time reducing the use of resources. Projects exist that lead to reducing the use of resources by 90% and reducing pollution to a fraction of its previous level (*e.g.* the *Factor 10* project of Schmidt and Bleek). It seems that such projects can be practically implemented at local level (municipalities and regions).

However, this demands initiatives from government and appropriate institutions, as well as a high level of awareness of ecological problems in society. When such awareness exists, the population places a high importance on environmental protection. In such a case, development can be understood simply in economic terms determined by technology and resources.

This line of argument leads us to the following conclusion – society's lack of awareness of the existence of ecological barriers to development means that alongside economic barriers one should mention another basic barrier to sustainable development – not the state of the environment itself, but society's lack of awareness regarding the environment.

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