Ecological Aspects of Climate Change

Ecological Aspects of Climate Change

By

Dan Constantinescu

Cambridge
Scholars
Publishing

Ecological Aspects of Climate Change

By Dan Constantinescu

This book first published 2024

Cambridge Scholars Publishing

Lady Stephenson Library, Newcastle upon Tyne, NE6 2PA, UK

British Library Cataloguing in Publication Data
A catalogue record for this book is available from the British Library

ISBN: 978-1-0364-1472-6
ISBN (Ebook): 978-1-0364-1473-3

CONTENTS

ACKNOWLEDGMENTS

My very sincere acknowledgments to all the team form Abisko Research Station for the permission to use the laboratories the impressing library and the permission to access some registred data. Special thanks to professor Jonasson, directory Magnus Augner, co-workers Annika Kristofferson and Linea Wanhatalo.

I wish also to tell thanks to my colleagues Dr. Eng, Adriana Beatrice Carlan for general collaboration regarding especially the graphs and the pictures. Thanks to Cristina Toma, this appears in the book as Alimoş.

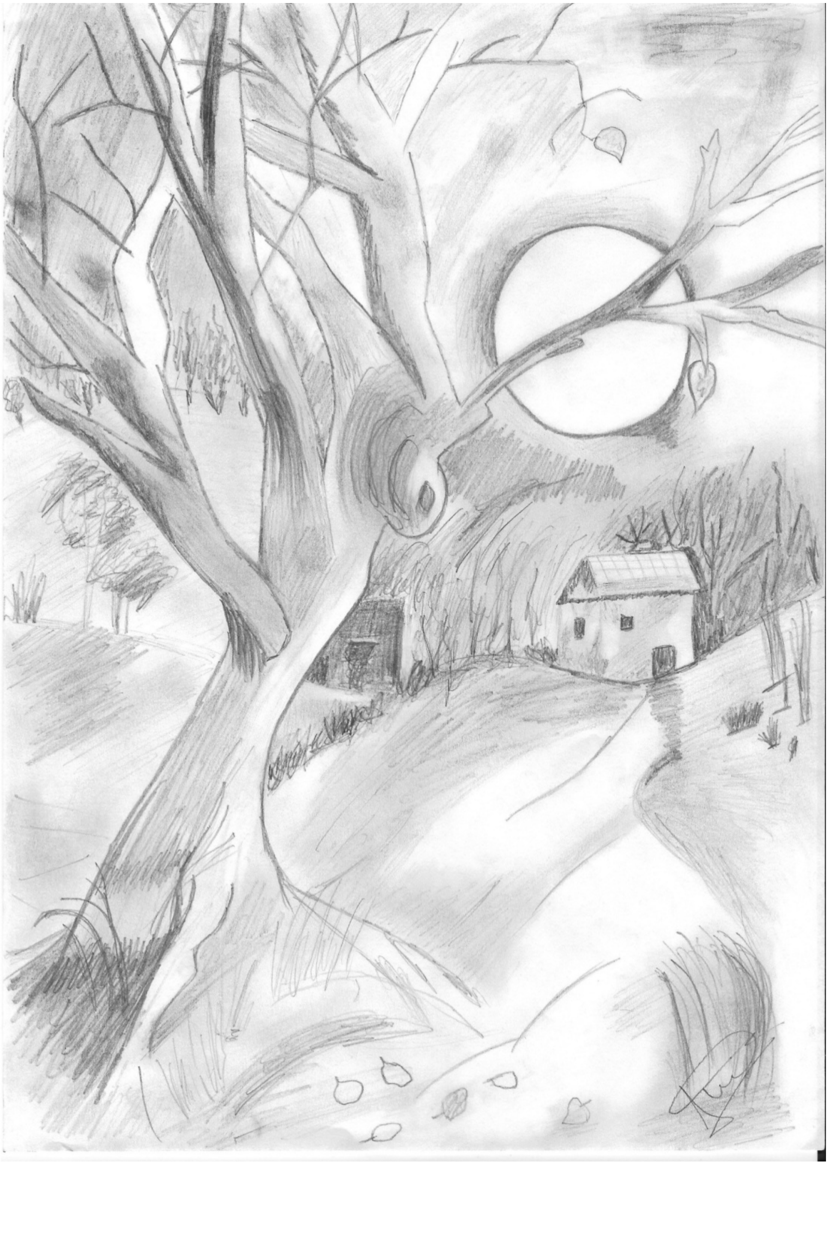
Thanks to my colleagues from the faculty Material's Science and Engineering, especially to professor Mirela Sohaciu and the young people from Ecomet for the data regarding the solar radiation.

Thanks for my students who have appreciated or criticized some aspects of the book during the preparation of some aspects.

Thank to my friend Nicolae Ghinea, who have encouraged me to finish this book.

I have to say many thanks to all the people who have supported me and who have not disturbed during my activity

1.Introductory Remarks



CHAPTER 1

INTRODUCTORY REMARKS

When we travel to visit natural sites or ancient historical sites, we may often discover a lot of aspects that may change our initial opinions and pre-established points of view. In many cases, one has to put in a lot of effort to differentiate between legends, traditions, scientific knowledge and reality. The reciprocal impact of an anthropic site, current or historical, with a bordering environment, as well as with human activities, is certainly very remarkable.

It is necessary to take many global evolutions into account, if we want to understand reality and grasp our eco-cultural evolution, our environment and, probably, our daily life.

The environment can be defined as a complex and systemic structure that integrates natural and anthropic systems and subsystems, linked by material, energetic and informational relations. The connections may include fields of physical, chemical, social, biotical and economical aspects, which contribute to the achievement of a balance able to ensure the structural and functional support of the components considered to be the central elements of the system.

The intervention of factors external to the system can disturb its equilibrium. The external factors can act upon the links of informational, energetic and material type, which connect the subsystem components, interrupting or disturbing them. The interruption, or the disturbance, of these links upsets the balance of the system. After the action of the external factors ceases, the systems resumes, within certain limits, its initial equilibrium.

If the intensity of the factors that interfere from the exterior exceeds a certain limit, which we can call the "influence threshold," *the links inside the systems will be disturbed or broken forever* and the system will be irreversibly thrown off balance. For instance, an ecological system that is affected by NOx (toxic gases, industrial dust, thermal radiations, etc.) will, for a time, react by means of the self-recovery factors, resuming balance.

But if the NOx exceed the limit to which the system can react to maintain its balance (the influence threshold), the system cannot re-establish the internal links and it breaks up. Many times, the influence threshold is of a cumulative type, in the sense that if, for a specific interval, the NOx (exterior factors) do not damage the system, it will be damaged after a prolonged period of action of these factors.

The ecological systems *have a self-adjustment capacity, permanently responding to the environmental factors that tend to disorganize them. Moreover, they have the self-adjustment capacity within some limits and in some specific ways.* That is why the intervention of the human factor (anthropic) within these systems, by means of artificial activities, must be done in such a way so as not to destroy this capacity and the balance of the system. If the ecological system loses its self-adjustment and its capacity to maintain balance, an "ecological catastrophe" occurs, which, most of the time, is not remediable.

A schematic representation of these types of systems is represented in the outline presented in figure 1.

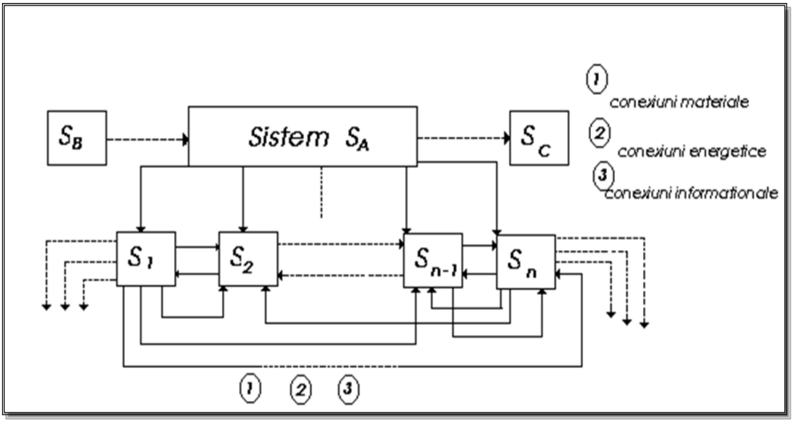


Figure 1 Connections within a system
1) material connections; 2) energetic connections;
3) informational connections

Regarding what concerns the ways in which the use of the systems can be applied to the analysis of the ecological mark and to the interpretation of the results it offers, we have to take into account the fact that the systems are made of components and attributes, which are described as follows:

a. *The components* represent the operational parts of the system, consisting of *input data, data mining and output data.* Every component of the system can involve a variety of values to describe the state of a system as a multitude of controlled actions and of one or more restrictions.
b. *The attributes* are the proprieties of the system's components
c. *The relations* are the links between the components and the attributes

The objective or the goal of the system must be defined and understood so that its components can offer the results expected for every set of data entered. Once it is defined, the goal enables the measures of performance to be established, which indicate how well the system acts.

By "action within a system," we will define a significant activity offered by the system, which is represented by its *function*. As a function of the system, we can name not only *the alteration of the material, the energy or the information* but also an equation or a system of equations attached to the respective system. The alteration adopts *the input data, the mining data and the output data.*

Systems that alter (modify) input data, material, energy or information consist of

- Structural components—the static parts
- Operating components—the parts that deal with the processing part
- The flow components—represented by the material, the energy or the information that are modified (altered)

Comparing the differences between a "relation" and a "system," one can notice the following:

- Firstly, a relation exists *between two or only two components*, while a system is described as an *interaction between many components*.
- Secondly, a *relation consists of the imminent features of the components,* while *a system is created by the specific position and the spatial distribution of the components.*
- Thirdly, *the link between the components of a relation is a direct one and the link between the components of a system depends on certain particularities of the whole multitude of components that make up the system.*

Furthermore, within the work, we should take into account the categories below:

- *The natural systems* or subsystems are those that appeared as a result of natural processes.
- *The artificial subsystems* are those in which man has acted by means of components, attributes or relations.
- *The physical components* are the systems that manifest in physical terms. They consist of real components and take up physical space.
- *The conceptual components* are the organisations of the ideas. The totality of the elements contained in the components, attributes and relations focused on a result imply a guiding process of the state of the system. The process can be mental (thinking, planning, learning) or mechanical (operating, functioning, production).
- *The static system* is a system with a structure but without an activity (for instance, the metallic structure of an industrial precinct).
- *The dynamic system* combines the structural systems with the activity (for example, a technological line, together with the staff that carries out activities for this line).

On the other hand, a system may be closed, open or isolated.

A closed system is a system that does not interact in a significant way with the environment. The closed system has a balance feature that results from the internal rigidity that maintains the system despite the influences that come from the environment. Closed systems imply decisive interactions, with a one-to-one correspondence between the initial and the final states.

An open system allows the information, the energy and the matter to exceed its limits. These interact with the environment; examples are plants, ecological systems, and economic organizations. It is characterized by a constant state within which a dynamic interaction of the elements of the system results in changes in the environment.

An isolated system (practically impossible), in theoretical terms, is a system that does not exchange either matter or energy with the environment; so, it does not interact in a material or an energetic way with other systems.

Open as well as *closed* systems present the property of entropy.

Within a natural or anthropic system, the entropy is defined as *the degree of disorganization* in that system and is analogous to the term used in thermodynamics. In thermodynamics, the energy results from the transformations from one form into another form. In the systems, greater entropy means increased disorganization. A decrease of entropy takes place as a result of the emergence of order[1].

Ecological systems can be considered among the most complex categories of systems. Nevertheless, how was it possible for such complex, sophisticated systems to be partially or totally affected? Of course, this cannot be explained only by means of economic and geographical aspects, but also by the role of the ecological marks and the climate changes from those periods.

The evolution of some historical sites, for instance, should be approached from the ecological and cultural points of view, but also from the point of view of changes to the environment and climate changes; but this approach is not unique. We should proceed by analysing the particularities of these very interesting types of local or global patrimony, by linking them with the influence of environmental changes over the evolutional or involution process of those. Maybe we have a lot to learn from what happened.

We can say that the *ecological footprint* came to be considered as the most modern solution for analysis, and that it enjoyed, despite the disputes it created, an intense publicity and great approval.

The ecological footprint of a population can be defined in a few terms as "the terrestrial and water surface productive from the biological point of view, which is necessary for the production of resources meant for consumption and assimilation of the waste produced by this population, regardless of the localization of the respective surface." Consequently, pursuant to the definition of Wackernagel and Rees in 1995, the ecological footprint is the productive ecological field necessary for the satisfaction of the consumption of a population and for absorbing all its waste.

The goal of the ecological footprint in the initial phase of its definition was to identify and propose new definitions and measurement units for

[1] For instance, life represents a transition from disarray to order. Carbon, oxygen, hydrogen atoms and other elements arrange in an ordered and complex way so as to produce a living organism. A purposeful decrease of entropy leads to the creation of an artificial system.

development, favouring the reorientation of the economy towards a superior capitalization of man and nature, with the purpose of taking into account the social and economic effects of the modes of development, effects that do not appear in the traditional economic calculations. There are certain minimum resource limits accepted per capita, which can be used constantly, long term. For instance, in a certain area, every citizen could consume the equivalent of 2.3 hectares of resources but, in reality, they consume 2.4 hectares. The extra 0.1 is "supported" by the areas (countries) that consume less resources, usually by poorer countries.

The ecological footprint can be considered an indicator of durable development, which is used more and more, nowadays. It is an important indicator that is frequently employed, at the international level, by non-governmental organizations to raise awareness of the anthropic pressure on the environment. Likewise, it is an indicator and a working instrument used more frequently by specialists in the field of ecology and environment protection sciences.

There are obvious and important correlations that can be established between the values of the ecological footprint and biodiversity. As the human ecological footprint increases, biodiversity decreases.

Consequently, knowing the range of the human ecological mark is relevant in what concerns the conservation of biodiversity because the material and energetic resources extracted from the natural resources for the benefit of the human population are not available for other species.

2. The Concept of the Ecological System as a Working System

CHAPTER 2

THE CONCEPT OF THE ECOLOGICAL FOOTPRINT AS A WORKING SYSTEM

2.1 Human Well-being and the Ecological Footprint

In 1970, the concept of "Gross Domestic Product" (GDP) was already frequently used as a basic indicator of the general level of development of national economic systems and of the living standard of their populations. The size of this global indicator has become a generally accepted and undisputed argument in the analyses of the degrees of economic evolution, the uses of resources and the increases in living standards. As a result, large sectors of the world economy have begun to assess their achievements according to the value of their GDP, which, in the space of several decades, has led to a greater acceleration of economic activities than before but also to the increased use of the material and energy resources of the environment, which is particularly evident in the current dimensions of the global ecological footprint.

Simultaneously, the global consumption of material products, and energy and information resources have made remarkable contributions to this phenomenon. All these elements must be analysed in the context of their close inter-relation within ecological or eco-industrial systems. As a result of the observations and analyses carried out in recent times, the question is increasingly being raised as to whether the world economy has finally managed to become, to a much greater extent, a threat to the natural environment and the quality of life, rather than the proponent of global development and well-being. It can be considered, with regard to the supply of material products and services, which are actually closely connected to consumer demand, that, every day, new data and information are being accumulated on its issues, generating major problems in terms of quality of life, public and individual health and, last but not least, the protection of the natural environment and biodiversity. It can, therefore, be considered that the ecological footprint is a resource management tool (materials and energy) that measures how much land and water a human population needs to produce the products they consume and to absorb the waste and residues resulting from the production and consumption of these products. To achieve the conditions of "quality of life," we consume what nature offers us. Each of the human actions has a certain impact on the global or local ecosystems. This should not be a factor of concern as long as human consumption does not exceed the Earth's regenerative power

The ecological footprint can be considered a global or zonal assessment element that measures the "amount of material and energy resources" associated with an ecosystem, which a population, country or area consumes. Through the current calculation systems proposed, the values are equivalent in units of area (global hectares, hag). The measurements are based on the presumption that any human activity uses resources and requires residue cleaning streams that can be equated to the productive area.

By measuring the ecological footprint of a population (of an individual, a current or historical site, a nation, a statistically defined population or the whole of humanity), it is possible to actually highlight the level of consumption, or surplus consumption, values that can be used for the management of environmental resources. The ecological footprint allows us to make personal or collective decisions in support of optimizing consumptions in order to remain within the functional parameters of the area, region or planet, which we can consider, in the specific conditions, as closed systems.

The ideas on the "ecological footprint" first appeared in a report from the sustainable development indicators program of an (initially non-profit) organization in the US: Redefining Progress. The objective of this institution was to identify and propose new definitions and units of measurement for development, favouring the reorientation of the economy towards a superior exploitation of human capacities and nature, aiming to take into account the social and economic effects of development modalities, effects that do not appear in traditional economic calculations. Thus, a new index was proposed—the Genuine Progress Indicator, a real indicator of progress, which was to lead to a revision of the GDP. The ecological footprint is a complementary indicator of this calculation, intended to take into account the influence of human activities on the environment, in terms of the use of resources, and the use of the capacity to assimilate and exploit the diversity of the environment.

An interesting comparison in this area can be made between "human well-being" and "ecological footprint." Based on the data from the "Global Footprint Network" and from the "UN Human Development Report," the graph presented in figure 2 was made.

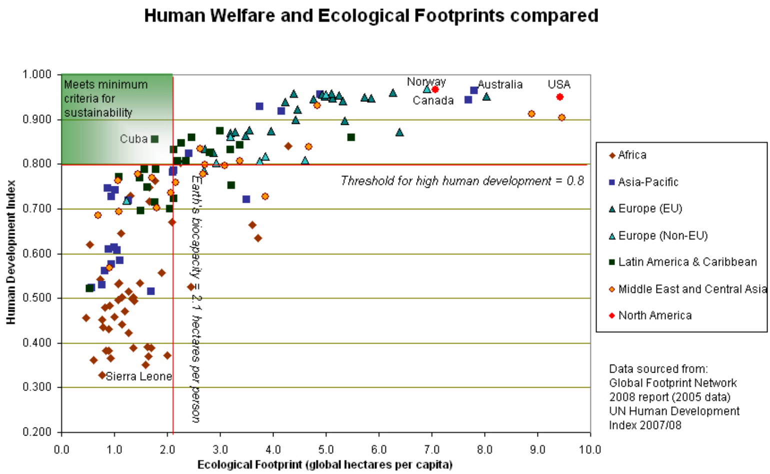


Figure 2: Comparative graph of human well-being and ecological footprint (by http://en.wikipedia.org/wiki/Ecological_footprint)

The Human Development Index (HDI) was introduced in November 2010 and updated in June 2011 and comprises the following components:

- Life Expectancy Index (LEI);
- Education Index (EI).

The calculation method proposed in 2010 (Human Development Report 2010, [3]) can be expressed through the following relationships:

$$LEI = \frac{LE - 20}{85 - 20} \qquad (1)$$

LEI is 1 when life expectancy at birth is 85, and 0 when life expectancy at birth is 20.

$$EI = \frac{MYSI + EYSI}{2} \qquad (2)$$

where

- MYSI = Mean Years of Schooling Index
- EYSI = Expected Years of Schooling Index (according to UNESCO 2010 definitions)

$$MYSI = \frac{MYS}{15} \quad (3)$$

$$EYSI = \frac{EYS}{18} \quad (4)$$

- MYS: average schooling period [4]
- EYS: proposed (estimated) period of schooling (according to UNESCO Institute of Statistics)

The index of the "decent standard of living," which includes the value of "gross domestic product," shall be determined by equation (5).

Income Index (II):

$$II = \frac{\ln(GNIpc) - \ln(100)}{\ln(75{,}000) - \ln(100)} \quad (5)$$

where

GNIpc = Gross domestic product per inhabitant, relative to purchasing power (gross national income at purchasing power parity per capita)

"II" is 1 when GNI per capita is $75,000, and 0 when GNI per capita is $100.

Finally, the HDI (Human Development Index) is given by the geometric mean:

$$HDI = \sqrt[3]{LEI \times EI \times II} \quad (6)$$

In 2012, this evaluation process of the HDI replaced another calculation method, which was based on other indicators, and is also used today in calculations on the analysis of the "ecological footprint."

In both cases, it is difficult to assess why one method or another was recommended, as well as the indications for entering some indices and their accuracy. Figure 3 show the factors of the HDI.

The calculation method for the ecological footprint at national level is described in the "Ecology Footprint Atlas 2010–2015" or, with more details, in the "Calculation Methodology for Ecology Footprint Values." It should be noted, however, that there are differences in the methodology used by different studies on the ecological footprint. For example, references to maritime areas are presented differently, the way fossil fuels are assessed is also differentiated, and the way in which nuclear energy is taken into account is not sufficiently clarified in relation to fossil fuels and is usually assimilated to them.

HDI is divided into four tiers: very high **human development** (0.8–1.0), high **human development** (0.7–0.79), medium **human development** (0.55–0.70), and low **human** development (under 0.55).

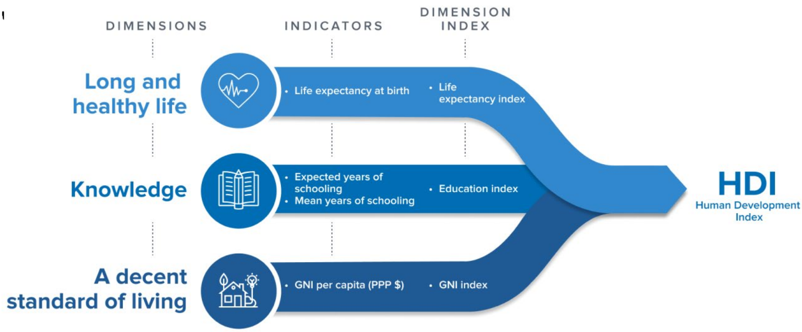


Figure 3: Factors of the Human Development Index (HDI)

The particularities of eco-zonal systems should also be taken into account to more precisely include the role played by biodiversity. Aspects related to import-export activities should be accounted for.

However, as new standards relating to the assessment of the ecological footprint, calculation methodologies converge.

In 2003, Jason Venetoulis, Carl Mas, Christopher Gaudet, Dhalia Chazan and John Talberth developed a theoretical methodology entitled "Footprint 2" that provides a number of improvements to the standard approach to ecological footprint [5], [6].

Four primary improvements were proposed: the authors included the entire surface of the Earth in the estimation of biocapacity, separate space was allocated for other species (i.e., non-human species), the equivalence base for agricultural land and net primary productivity factors (PPN) was updated, and the carbon footprint component, based on the latest models, was reassessed, on carbon, worldwide [5], [6].

2.2 What the Ecological Footprint Actually Is

Broadly speaking, the ecological footprint is the measurement of the impact of a human population on the environment. Its value can be expressed as the total area of productive land and water needed to cover all resources consumed and to recycle the waste produced. In principle, therefore, the ecological footprint is an objective indicator that synthetically expresses the anthropogenic pressure exerted on the biosphere.

The ecological footprint of a population can, therefore, be defined as "the biologically productive terrestrial and aquatic surface necessary for the production of resources intended for the consumption and assimilation of the waste produced by that population, irrespective of the location of that area" (Rees and Wackernagel 1997). If it is highlighted, the capacity of the environment to support human activities, translated into spatial terms, allows us—according to the original idea of the concept—to assess the sustainability of the current exploitation of the environment. At the present stage, quite complex calculations are carried out with results that are embedded in annual reports.

If we take the year 2000 as a benchmark, we could show, for example, that the average world citizen had an ecological footprint of 2.3 gah (global hectares), compared to the average US citizen, with an ecological footprint value of 9.6 gah.

Such a situation would imply the need for a change in the modes of development, which would, in some way, penalise illegal environmental exchanges and stop the achievement of biophysical limits. According to the same estimates, cases exceeding the value of resources in the sense of acceptable sustainable development were 20 %; humanity "consumed" 120 % of the planet.

These values are perhaps more difficult to understand if one does not take into account the situations of zonal developments and how the production of waste influences the state of the ecosystems. It has been said—also in this context—that it would take three planets Earth to support human activities if the world population lived at the level of the Europeans or Americans.

The assessment of the ecological footprint can be done by the category of activity. The demand of the human population on the productive biological space can be evaluated by six types of environmental use:

- land intended for agricultural crops
- pasture
- logging
- fishing in fresh and salty waters
- infrastructure
- areas operated for the purpose of extracting fossil fuel

Therefore, for each way of using the reference space, to establish the ecological footprint, it is necessary to measure—each year—the anthropogenic demand and the existing biological capacity, which implies, on the one hand, the estimation of the areas of the planet destined for each type of activity and the area potentially available for these activities, and, on the other hand, that they are all brought to the same standard to convert them according to biological productivity. To achieve this, those who promote this indicator expect, and ask for, support in providing the necessary data for systems that depend on the United Nations and the national statistical institutes.

As for the connection between the ecological footprint and the use of natural energy resources, the problems are quite complex. From the use of basic natural energy resources (such as wood, for example, in the early stages of the evolution of human society) to the use of nuclear energy or unconventional energy sources, problems must be addressed differently. Therefore, the following groups of energies with economic applicability can be distinguished according to the analysis of their ecological footprints:

- natural gaseous hydrocarbons
- wood
- natural liquid fossil hydrocarbons
- solid fossil energy sources,
- hydro energy
- nuclear energy
- unconventional energy sources (wind, solar, geothermal, maritime)

Currently, the ecological footprint related to the consumption of fossil hydrocarbons and coal is measured by the area needed to absorb the CO_2 emitted by combustion, assuming that the oceans absorb about 35 % of these emissions and that the forests play the role of storage container for the remaining 65 %. This latter assumption decisively influences the level of the ecological footprint related to energy consumption and, more broadly, the level of the global ecological footprint. According to the initial calculations presented by Wackernagel (1997), almost all the increase in the ecological footprint between 1961 and 1999 was linked to energy consumption. Nor should it be forgotten that the evolution of energy consumption in various historical periods has often led to the depletion of natural material sources, such as forests, for example.

As a first-level application, the ecological footprint is proposed for comparisons at a global level: expressed on the whole territory or on an individual level, it allows the presentation of the limits of the level of development of one territory compared to another. The ecological footprint can also indicate whether the development of certain areas is carried out at the expense of others: their ecological footprint goes beyond the usable territory; thus, becoming tributary to other natural resources. In this situation, either the overexploitation of one's own territories or the abusive exploitation of other territories occurs. This indicator is increasingly mentioned in the context of prior impact assessments required for spatial planning projects or to quantify the pressure exerted by certain activities.

The spatial aspect is of no particular interest to transnational companies, for which the reference territory necessary for the calculation of the footprint is irrelevant, being one “wasted” in space. As an “aggregated” indicator, the measurement of the ecological footprint involves choices in terms of weighting, substitution or addition of different types of pressure and environmental functions. Although these assessments were not a novelty in themselves, the varied manner and context in which they were presented was exciting at the time.

Human development is based on the state of ecosystems and the services they provide the state of resources and waste in connection with their absorption capacity. Changes occurring in the ecosystem (e.g., forest use, resources provided by lotice[1] and lentice[2] systems, mineral resources,

---

[1] Terrestrial systems of lakes
[2] Terrestrial systems of rivers

accumulation of carbon dioxide in the atmosphere) may indicate that anthropogenic demand has exceeded, or is on the verge of exceeding, the regenerative and absorption capacity of the biosphere.

Controlled management of human interaction with ecosystems at global or local levels is essential to ensure sustainable development in the coming periods. The assessment of historical trends also provides an important database for setting future objectives and identifying options for action to achieve the stated objectives. Data on the ecological footprint, at the national level, constantly provide information on which human activities for the use of natural resources affect the temporal evolution of the countries concerned.

It is worth mentioning that, since 1997, Mathias Wackernagel and his collaborators at Universidad Anáhuac de Xalapa (Mexico) have provided computational solutions to determine the ecological footprint and biocapacity at a global or national level [2, 7, 8].

Based on these analyses, in 2003, the "Global Footprint Network" initiated the publication of annual reports, the most recent edition being from 2014.

The demand for resources and activities imposed by the world's population on the biosphere in a given year—relative to the prevailing technologies and resource management of that year—can be defined as the "ecological footprint" for that period.

The supply of resources by the biosphere, namely biological capacity (biocapacity), is a measure of the biological amount of production of available land and sea areas. Green systems provide the resources and "ecosystem services" that the human society consumes, which contribute to the achievement of the green budget—according to the definitions given by Wackernagel (2002) [9].

In order to obtain a real analysis of the evolution of the ecological footprint, it is necessary to introduce specific indicators.

According to a general understanding, an indicator must be measurable, i.e., it must sense the dynamics or describe a situation that is subject to quantification. It must have a scientific basis and be relatively transparent (that is, easy to interpret). One can speak of the functions that the indicators must have, in a traditional way: to reflect phenomena or developments, to be close to a broad understanding, and to guide the making of a decision in the respective field. When it comes to evaluation, from the perspective of sustainable development, the need to take the many components of this type of development into account increases (economic, environmental, social and cultural).

In some analyses, it is desirable to integrate, even, a historical, forward-looking dimension to highlight past developments and assess long-term trends. Indicators should be calculable, within a longer or shorter time. For pragmatic reasons, the mode of application often consists of reorganising existing information, rather than finding systems that allow the collection of new data.

Given the complexity of the situation, which must be transposed into a series of indicators, it is easy to see the difficulty of achieving "conciliation" between the clarity and depth of knowledge, the aspirations of decision-makers, rigorously scientific issues, the novelty of information and the dynamics of society. In this approach, we started from indicators—mainly economic, already widely used. Despite the controversies it has created, and the criticisms that have been made of it (the failure to adapt it to environmental policies, the fact that it does not provide a solution that leads to a reduction of the impact, the fact that it does not allow the comparison of the different ways of using a territory, that it does not take into account the reality of the pressures exerted on the environment), it can be considered that the ecological footprint represents an effective measure for calculating the consumption of a given population, closely related to the ecological capacity of a particular territory.

In its current analytical form, the ecological footprint includes (see details in Chapter 5):

a) References to land agricultural area intended for the production of crops for direct or indirect human consumption
b) Pastures and grasslands necessary for the rearing of animals intended for food production
c) Forests intended for the production of wood for energy consumption or industrial processing
d) Water areas (lotice, lentice) intended for fish production or human consumption
e) Coastal or offshore sea areas from which efficient food production can be obtained
f) Areas of land needed to assure the human habitat
g) Vegetation areas (especially forests) necessary for the absorption of gas emissions from energy processes

The *ecological footprint* can be calculated in relation to different areas or systems. One can calculate the "ecological footprint" at the level of the entire planet, of a country, of a community, of a dwelling, or at the individual level.

Highly developed countries have very large ecological footprints as they use large amounts of natural resources and produce large quantities of waste. In fact, if everyone lived like they do in the developed countries, we would need five planets to provide enough resources for everyone, and, within just fifty years, we would need eight Earths.

The "Living Planet Report 2020" [10] provides data worthy of consideration (figure 4).

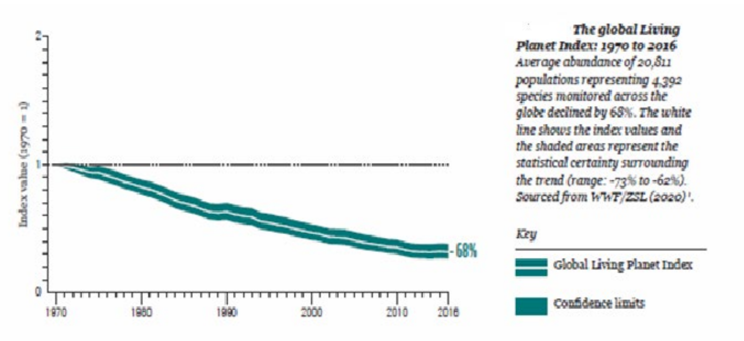


Figure 4: Global Living Planet Index, according to the WWF (World Wide Fund for Nature) and the ZSL (Zoological Society of London) Data

Figure 4a: Bear family on Transfagarasan Road, Romania (photo: Mariana Purice, 12.09.2021)

The LPI indicator (figure 4) shows a decline of 68 % between 1970 and 2018, calculated by the WWF, which means a significant reduction in the number of species, mammals, birds, reptiles, amphibians and fish. The white central line represents the value of the calculated index and the hatched areas represent the confidence level of the obtained results (about 96 %). It can be appreciated that these changes are an effect of the increase in the impact of the ecological footprint. At the same time, the evolution of biocapacity and ecological footprint is changing, as shown in figures 5a and 5b.

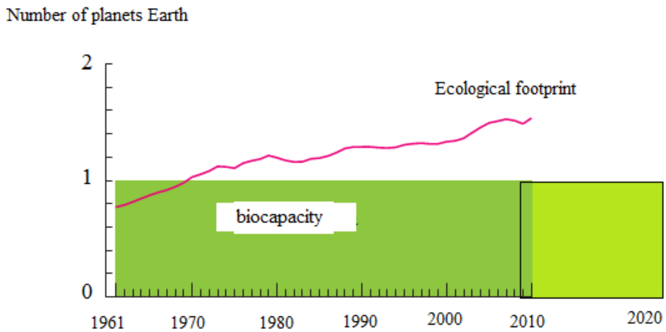


Figure 5a: Ecological Footprint and Biocapacity Determined in the Living Planet Report 2020

From the evaluated data, it follows that 1.5 Earths would be needed to cover humanity's demand for natural resources. At the same time, it can be noted that the value of biocapacity has remained unchanged.

The Global Conservation Organization’s Living Planet Report 2006 [11] presents a multi-scenario assessment of the evolution of the global ecological footprint, up to 2100 (Figure 6).

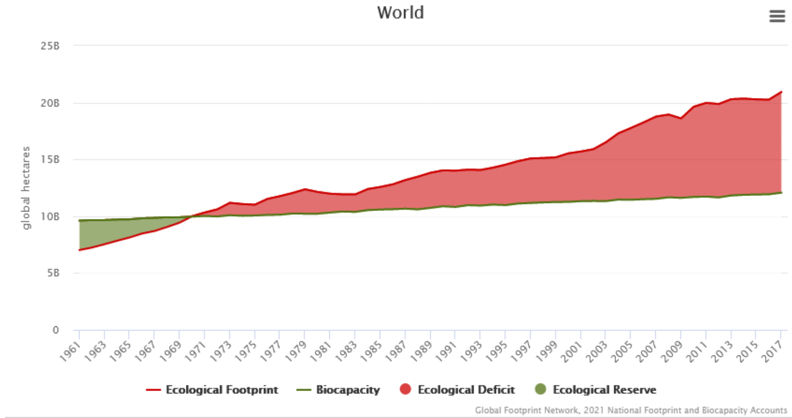


Figure 5b: Ecological Footprint, Biocapacity, Ecological Deficit and Ecological Reserve (World)

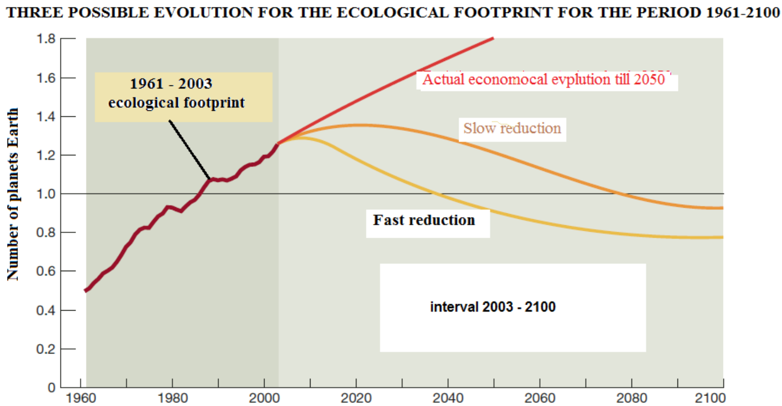


Figure 6: Assessing the Evolution of the Ecological Footprint (after the WWF, the Global Conservation Organization, and the Living Planet Report 2016)

The need to act to reduce the human ecological footprint can be noted from these calculations. This is, of course, an assessment of the overall ecological footprint. As I pointed out, the situation can be very different depending on the countries or areas analysed. For example, figures 7 to 21 show (according to the Global Footprint Network) [12] the ecological footprint situation for some EU member countries, for the USA, Canada and Japan, but also for some developing countries.

It can be said, therefore, that the ecological footprint is shaping up to be one of the intuitive solutions, of consistent multidisciplinary research, that, through its modern spirit, enjoys—despite the disputes it has created—an intense media coverage and wide acceptance. The purpose of the ecological footprint is to identify and propose new definitions and units of measurement for development, favouring the reorientation of the economy and the development of science towards an efficient capitalisation of human activities and nature, also aiming to take into account the social and economic effects of the ways of development—effects that are not included in traditional economic calculations. Human activity has left its mark on the quality of the environment in the Romanian area, especially over the last 150 years. Areas adjacent to the Danube, the Carpathian or intra-Carpathian mountains would be just a few examples to consider in this respect. The quality of the waters in these regions, whether potable, for irrigation or industrial uses, as well as the living environment for biological organisms, have often been affected. However, we must not overlook the possible effects of the ecological footprint on their historical evolution. Although the data are more difficult to access and difficult to interpret, the evolution of some historical sites, such as dacian or Roman-Byzantine sites, are systems that are of real interest in analysing the role of the ecological footprint in the evolution of human society.