

The Rural Ecology textbook is designed for the needs of students of the graduate (master) study program "Sustainable Management of Land and Rural Area" at the Faculty of Agricultural and Food Sciences of the University of Sarajevo, as well as other master study programs, at their own discretion, and higher education institutions in Bosnia and Herzegovina (Mostar, Zenica, Tuzla, Bihać, Banja Luka, etc.). It could also be a useful scientific material at Polytechnics in these towns and elsewhere. When the graduate master study is concerned, this textbook fully covers the subject matter (module) that was developed within TEMPUS Project "Western Balkan Rural Extension Network through Curriculum Reform" (WBREN) in collaboration with the Agricultural Faculty in Banja Luka, where this subject is entitled "Rural Development" and taught in master studies. The textbook can also be used to a considerable extent for other subjects such as Agro-ecological Zoning, Planning and Sustainable Development of Rural Areas, Ecopedology etc., studied in the master degree program "Sustainable Management of Land and Rural Area" at the Faculty of Agricultural and Food Sciences of the University of Sarajevo, as well as other master degree study programs in the area of environment and sustainable management of natural resources.

Prof. Dr Ivica Kisić, excerpt from the review



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RURAL ECOLOGY



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RURAL

ECOLOGY



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RURAL ECOLOGY



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PREFACE

The issues of rural development, being the most popular issue within the EU and in our country as well, have contributed to a better understanding of the significance of the interaction between humans and natural ecosystems that have always been there to support their survival on Earth. Although sustainable development is still an abstract concept, it is as strong as many other concepts such as freedom, equality and justice (Sophocleous et al. 1998). Once a resource has come under the human control, its balance starts to deteriorate. After this point, there are only two options: either a new equilibrium is established, usually at a lower level, or a status of disequilibrium prevails leading to a steady degradation or deterioration of functions, production and services of resources in the system.

Both cases have been known throughout human history. Sustainable agricultural exploitations were established in some parts of the world, where they replaced the natural ecosystems. That type of exploitation facilitated the spread of the human race. This is mostly the case in Central Europe. However, in some other cases the exploitation of natural resources has led to an abrupt growth of the local residents and human activities that are followed by increasingly enormous pressure on natural resources, as well as to poverty and abandonment of land. A true example of such case is the Mediterranean region. In many cases, once a man has succeeded in completely exhausting a resource, he seeks the new ones through migrations and trade contributing thus to the expansion of gradual degradation. In other cases, he is trying to replace one resource with another (coal for wood, petroleum for coal). In doing so, they often manage to avoid the suffering due to degradation or exhaustion of resources they have caused. Ecology is a very broad scientific discipline and therefore it is extremely difficult to address environmental issues in a narrow specialized way. It is always necessary address a wider problem for a better understanding, especially when rural areas are concerned, taking into account their entire natural, cultural and historic complexity. This is exactly the biggest challenge in writing such books or textbooks.

Ecology has stemmed from biology, but today it is an independent scientific discipline with huge dynamics in development and information. Many of its postulates within human ecology are in line with the medical perspective on the environment. In addition to biologists, environmental issues are also dealt with by other professions such as doctors, architects, agronomists, economists, various engineers, chemists, physicists, etc. There are several ecological disciplines: human ecology, autecology, idioecology, demecology, phytoecology, zoocology, social ecology. However, ecology can be divided into general (theoretical) and applied (practical) ecology, and recently there are attempts to establish some other ecologies such as urban

ecology, rural ecology, ecology of culture, ecology of radiation, etc. In this sense, the authors of this textbook have made an effort to present the problem of rural ecology as an approach derived from the development of Curriculum within TEMPUS Project 15877, *Western Balkan Rural Extension Network through Curriculum Reform (WBREN)*. The University of Sarajevo, Faculty of Agricultural and Food Sciences and the University of Banja Luka, Agricultural Faculty, are the two institutions from Bosnia and Herzegovina participating in this project. The content of this textbook has been defined at the joint working meetings of all the project partners from 12 universities: four from the EU and the rest from the Balkan Region, Macedonia, Serbia and Albania. The textbook will be published in English language too. We would like to take this opportunity to express our gratitude to all those who supported us and gave us valuable suggestions thus contributing to its quality. Special thanks go to the reviewers of the textbook.

Sarajevo, 2013
The Authors

1. INTRODUCTION

ECOLOGY – CONCEPT AND DEVELOPMENT

Ecology is a young scientific discipline that has started receiving a lot of attention worldwide in the past years. It is both natural and interdisciplinary science which builds up on the foundations of biology, geography, geology, chemistry, physics and mathematics.

The term ecology comes from Greek words:

- **Oikos** - house, home, dwelling place, habitation
- **Logos** - science, study of, learning, discussion.

German zoologist, naturalist, philosopher and evolutionist Ernst Haeckel (1869) used the word ecology for the first time in 1869 in his book entitled *General Morphology of Organisms*. According to him, ecology is the economy of nature which pertains to the relations between living organisms and their both organic and inorganic environment.

In early 20th century, Alexander von Humboldt, a German explorer, naturalist and geographer who stated “everything is interrelated”, in his works presents his

view of distribution of plant species primarily in relation to external conditions (climate). Thanks to him, in 1921 the Agricultural Faculty in Perugia established a department of agroecology.

At the beginning of the twentieth century, biologists were engaged only in biology, chemists in chemistry, geologists in geology, physicists in physics ..., until the beginning of 1962 and publication of the book entitled *Silent Spring* by a renowned American marine biologist and conservationist Rachel Carson. Her book brings into focus the application of a pesticide (agent for mass destruction of plant pests) known as DDT, as well as an inducement of various mutations in flora and fauna exposed to its effects. Her open and fierce criticism of this practice in her book eventually resulted in a ban of application of this pesticide. In a way, this book raised environmental awareness in people, and later on this scientific discipline started getting more publicity worldwide.

Nowadays there are numerous definitions that attempt at determining the subject of ecology. According to the above cited Haeckel E. (1869): ecology represents a science that addresses complex interactions between organisms and their environment, organic and inorganic. Ecology is the science of distribution and abundance of organisms according to Anderwarth (1961). Krebs (1972) defines ecology as a science of interactions which determine the distribution and abundance of organisms.

In a broad sense, many believe that Ecology is the science of ecosystems, environment, the science of general and specific manifestations of the struggle for survival, as well as the science of processes and methods which living organisms use to adjust to continuously changing living conditions, or simply said - ecology studies the totality of relations that living organisms have with respect to each other (common life) and their natural environment. Đukanović, 1996, conveys a definition by Radkevič, who sees ecology as purely *"biological science which studies mutual relations between organisms as well as their relation to the environment"*.

Clearly, it is extremely difficult to give an answer to the question »what is ecology» while respecting everything that modern ecology implies and pertains to conceptually. Therefore, all above stated definitions of ecology are incomplete. They, at a first glance, outline the issue of the human environment (environment) as an issue of modern civilization and destiny of mankind. However, it is not just about drastic degradation of the environment due to human activity, but also about its improvement and development, which is often overlooked. Nowadays, enormous resources are being invested in new scientific-technological solutions, projects and systems in order to remove or at least partly mitigate the effects that have become a serious threat to the survival of many organisms and ultimately the mankind itself. Such an approach and understanding of environment resulted in the establishment of a science which, unfortunately, has not fully shaped up its domain. It is commonly

defined as ***the science of protecting and improving the environment***, and as such it is more complex than ecology in all aforementioned original concepts. It could be simply defined as the science of human's impact on the environment.

In any case, through familiarizing us with ecological principles, ecology provides information which allows us to have a better understanding of the world that surrounds us. Good knowledge of these ecological principles contributes to the improvement of environment, proper management of natural resources and protection of human health.

MAJOR SUBDIVISIONS OF ECOLOGY

Since it is a scientific discipline, and based on the subject of studying, Ecology can be divided into Phytoecology and Zooecology. As their names indicate, Phytoecology takes the plant as a subject of study and Zooecology studies animal organisms.

On the basis of method of study, Ecology can be subdivided as:

- Idioecology (Autoecology), analytical science that examines the relations between individual organisms and conditions of the environment. Its primary task is to study the relations between individual organisms and external factors.
- Sinecology (Synthetic ecology) applies synthetic method in the study. It has three levels, as follows:
 1. Relations between the population and external environmental conditions;
 2. Relations between the community (phytocoenosis and zoocoenosis representing a set of diverse populations) and external environmental conditions; and
 3. Examination of ecosystems representing the unity of the biotic community and biotope. This examination also includes examination of mutual relations within a biotic community.

According to the most basic geophysical characteristics of Earth, ecology can be divided into terrestrial (on land) and aquatic (marine and limnology) ecology.

A subdivision of ecology by type of organisms includes:

- Microbial ecology (ecology of microorganisms),
- Phytoecology (plant ecology),

- Zooecology (animal ecology), and
- Human ecology (ecology of man).

The most common subdivision of ecology by the level of organization of studied systems, the relations to the size and organization of a segment of biotic and abiotic components of biosphere includes the following:

- Autoecology (ecology of individuals/species),
- Demoecology (ecology of population),
- Sinecology (ecology of living communities/biocoenoses),
- Geocology and global ecology (planetary ecology)

ECOLOGY – STUDY APPROACHES

According to the above cited Radkevič (1983): “*Modern ecology is a theoretical base for rational utilization and protection of nature, which has its specific contents, subject and tasks, as well as research methods*”. While explaining the term ecology in his book *Tourism and Ecology*, Mueller H. (2004) emphasizes that ecology, being the science which deals with complex interrelations, provides an insight into complex natural systems but offers no guidance as to what we should or should not do. In this sense, it is neutral. In order to substantiate this statement, he provided an example showing that ecology does not, in fact, care about human-caused excessive CO₂ emission to the atmosphere. This emission results in the environment to react in the sense of adjusting to the newly created conditions (climate changes – warming, as well as increased intake of CO₂ from the atmosphere by green plants and ocean plankton). However, the problem occurs when such adjustments are in contradiction with human interests, thus affecting our lives and economy. In addition, we need to understand that ecological balance in a group of organisms or an individual does not necessarily represent a balanced system for another one. He cited Juergen Dahl (1984) who, in his book entitled *The Garden And Its Incomprehensible Devastation*, describes this correlation between the evaluation and interest of the subject on the example of a common housefly: „If a housefly is brought into the situation to evaluate environment it surely would find the absence of rotten flesh a problem which directly threatens its existence”. Mueller H. (2004) concludes that, in order for instructions on action or limitations of action to be performed for *ecological* reasons, it is necessary to supplement ecology with ethical principles. At best ecology can indicate the processes and the effects some occurrence causes in a given ecosystem, but the action aimed at preventing the cause, if effects pose a problem, it depends on man and society who judge the values and set standards, and which is based on ethical considerations.

In 1972, the ecological scene heard another extraordinary voice coming from a Norwegian philosopher and ecologist - Arne Naess. At a lecture in Bucharest, he presented his *concept of deep ecology*, which made a strong impact and realized a number of approaches and ideas related to the environment during the last decades of the twentieth century. Unlike that ecological movement dealing with consequences, he called *superficial ecological movement*, Arne Naess advocates for much deeper causes concerning principles on which rest on the whole living world. The superficial ecological movements address the issues of pollution and over-exploitation of resources while deep ecological movements deal with issues such as principles of diversity, complexity, autonomy, decentralization, symbiosis, egalitarianism, classlessness. To this effect, the author of the new doctrine calls all superficial ecological movements *anthropocentric* as they support the protection of environment motivated by human interests, whereas other ecological movements are *ecocentric* as they originally start from the point that the natural world outside man has the right to exist regardless of how beneficial it could be for mankind. In this context Carter (2004) points out that "*Human arrogance towards nature is rooted in anthropocentrism: the belief that ethical principles apply only to humans and that human needs and interests are of higher, perhaps exclusive significance - humans are placed at the center of the universe, separated from nature and endowed with unique values.*"

Appreciating the fact that significant actions and measures of environment protection are being undertaken in almost all spheres of activities, we have to say that, unfortunately, we are still in the stage of determining the proper strategy hence many current measures and actions can be characterized as incomplete, interim and unfinished. There is an encouraging fact that the relation of contemporary man to the environment has significantly changed, and it could be stated that ecology has in a way become a significant social problem and part of the inner circle of mankind's existential issues. The ecological issues appeared and developed during the era of socioeconomic development, and it is thus no longer possible to ignore them.

ECOLOGY AND SUSTAINABLE DEVELOPMENT

In relation to ecological and economic problems, a widely accepted position on sustainable development, and currently predominant, is the one which implies a maximum possible balancing of technical and technological development and preservation of the environment. This concept, after the UN Conference on Environment and Development held in Rio 1992, becomes globally known and penetrates all pores of human society. In the report called the Brundtland Commission Report, the UN describes sustainable development as development which meets the needs

of current generations without compromising the ability of future generations to meet their own needs.

There are numerous definitions of sustainable development and for all of them is common that they are linked to the limited natural resources. In the ecological sense, sustainability can be defined as the way in which biological systems preserve their productivity and diversity over time. To humans, it is a capacity for long-term maintenance of wellbeing which is yet dependent on the wellbeing of the natural world and responsible use of natural resources.

Sustainability has become a broad term that can be applied on almost all shapes of life on Earth, from local to global levels and through various time periods. The long-standing marshes and forests are examples of sustainable natural resources. Numerous chemical cycles, invisible to the naked eye, are being redistributing water, oxygen, nitrogen and carbon within both biotic and abiotic systems worldwide, and have sustained life for millions of years. As the human population on Earth **grew bigger**, natural ecosystems regressed while changes in the balance of natural cycles had a negative effect on humans, as well as on other biotic systems.

According to Bookchin (2004), the idea of nature dominated by man is common in hierarchical societies. Bookchin claims that capitalism and market relations, if not under control, have the ability to reduce the planet to a mere resource which is there to be exploited. Nature is thus treated as a convenience: *“The plundering of the human spirit by the market place is paralleled by the plundering of the Earth by capital”*. Even more convincingly, Bookchin (2005) claimed that the majority of activities consuming energy and destroying environment are senseless since their contribution to the standard of living and wellbeing is small. Primary function of work is to legitimize or even create a hierarchy. For this reason, a good understanding of the transformation of organic societies into hierarchic is crucial for finding ways to progress.

There is a large number of scientific evidence that the mankind lives in an unsustainable way. Reversion of humans' utilization of natural resources into the boundaries of sustainability will require an enormous collective effort. A more sustainable way of living may take a number of various shapes, to include:

- Reorganization of living conditions (e.g. ecovillages, eco-municipalities and sustainable towns),
- Reassessments of economic sectors (permaculture, green building, sustainable agriculture) or work practices (sustainable architecture)
- Application of science in development of new technologies (green technologies, renewable energy)
- To adjustments in individual lifestyles aimed at preservation of natural resources (Earth Policy Institute 2009).

The sustainability principles can be divided into 4 groups (James, 2003):

1. Reduce dependence upon fossil fuels, underground metals, and minerals,
2. Reduce dependence upon synthetic chemicals and other unnatural substances,
3. Reduce encroachment upon the nature and
4. Meet human needs fairly and efficiently.

However, one cannot get away from the impression that the idea of sustainable development is a kind of compromise attempting to reconcile ecological stability on one and social stability on the wings of economic development (hidden behind the interests of capital), on the other side. According to Guggenbuehl (2002) the vague term „*sustainable development*“ has just slightly softened the frontline between environmentalists and those promoting economic development but did not alleviate the problems (states Mueller, 2004).

RURAL SPACE AND RURAL DEVELOPMENT

Simply said, rural space represents everything that does not belong to urban space. Spatial, ecological, social and cultural dimensions define it. It is a space that originally serves as living and working space of the rural community, predominantly of peasants – farmers. It is characterized by rural landscapes defined by ecological and agricultural production (mainly natural environment), traditional rural settlements, as well as internal and external appearance of houses and gardens. Along with this material base, some specific cultural patterns are formed, developed and fostered simultaneously – traditional lifestyle and work of the rural population (traditional skills and methods of agricultural production, housing, clothing, diet and specific collectiveness), as well as intangible properties (folk dances, songs, legends, specific dialects, etc.). We can say that such defined rural space is viewed as one of the key elements of the overall diversity of human society, as well as an important link in its preservation.

Specific peasant collectiveness can be viewed from different angles:

- Peasant societies have relative autonomy from global society, which reflects in economic autonomy and autonomous social relations and culture;
- The essence of economic life in rural society is organized within the householder group with clear division of work. The householder group

is characterized by stability and heritage base while, in terms of the economy, it represents both production and consumer unit;

- Peasant economy is self-sustainable and serves for reproduction of the householder group (work for food) and peasant collectiveness;
- Peasant collectiveness is a type of society of mutual acquaintance, and the only differentiation the peasant society recognizes is by gender, age, role in householder group or specific function;
- Global society communicates with peasant collectiveness through their most distinguished representatives.

In the fifties of the past century, terms of underdeveloped rural areas and rural development were introduced. Sustainable rural development represents a concept of planned rural changes based on the idea of sustainable development + sustainable (ecological) agriculture. Rural development implies a change of attitude toward traditional rurality as well as a change of the rural role in relation to national/global perspectives. It places its focus on cohabitation of the local community and biosphere while increasing the significance of the local in environment protection.

The context of goals set for rural development implies a modernized rurality wherein protection of environment, economic stability and equal opportunities will be accomplished for all.

The top priorities are as follows:

- To preserve natural originality of rural space (rural complex as a cultural complex)
- To create prerequisites for new jobs
- To open perspective for the rural population (a village of citizens, media, sports, culture, tourism, different generations)

This concept would be realized in parallel through four frameworks:

1. Political and institutional framework
2. Development of technological base
3. Interaction between human activities and natural resources
4. Urban-rural connectivity

In this context, a model of mixed farm is being introduced. The criteria are sources of income and types of activity. The mixture implies the presence of both agricultural and non-agricultural activities. In the early 19th century, development of rural industries took place, i.e. – the peasants brought industry into villages in order to avoid seasonal migrations. At the same time, many crafts were developed thus developing a new class of peasant-workers.

Model of mixed farm is an economic and socio-cultural model which implies:

- Process of agricultural modernization
- Introduction of entrepreneurship
- Rural tourism
- Development of actual values such as diversity and sustainability
- Risk issues
- Critical valorization of experience

The social effects of this mixture would include mitigation of social conflicts, alleviation of pressure on urban centers, physical changes in settlements, increased communication with cities as well as a new stratification in rural areas, disappearance of traditional rural elites, change of values and needs, new problems related to the pollution of the rural environment, new individual and cultural requirements of the rural population.

RURAL ECOLOGY

Rural ecology actually deals with the issue of establishing balance between rural population and local natural resources. Since the stability of resources impacts the stability of population size, demographic regime of the village was relatively stable. Should it be disrupted this would have led to rural migration of surplus rural population, unable to earn their living in the countryside, to move to industrial towns and suburbs.

During the past decade, western sociologists dealing with rural space have shown an increased interest in topics related to the quality of the rural environment, structure of agricultural production and underdevelopment of rural space. Buttel (2008) analyzes the depth of cohesion of these phenomena, pointing out that current change in the structure of agricultural production made crucial impact on both rural environment and socioeconomic structure of rural community.

At the same time, the government policy has played a key role in shaping the changes in the rural community. In this context, we could mention the example of France, which advocated the policy of preserving rural population, whereas English policy upheld industrialization and rural emigration. In the former Yugoslavia socialism devastated traditional agrarian structure and after the WWII a total number of peasants dropped by 30%. A holistic or integrative approach is necessary for understanding the origin of such social and economic problems of the rural community, in order to conceptualize a strategy for their solution.

Social ecology, according to Bookchin, is based on the conviction that almost all current ecological problems of humanity are stemming from the deeply rooted social problems. While the majority of authors emphasize that all our ecological problems may be solved through the implementation of recommendations deriving from physical, biological, economic and other studies, the Bookchin's statement explains that such problems can be solved only through a good understanding of underlying social processes and intervening in the processes by applying the concepts and methods of social science.

It can be said that the emergence of social ecology represents a turning point, a sort of liberation of ecology, particularly of the human one, due to the impact of bioecology on it. The social ecology or ecological sociology as some theoreticians call it, being a science appreciating discoveries of human ecology and goes a step forward respecting relations of man and his environment, as well as social processes and interactions in which given relations take place, explains the man as a natural and social being. Social ecology, although it is a social science, builds on ecology's discoveries, especially those of human ecology. Social ecology studies the specific spatiotemporal relations of live beings as conditions of common human living, as well as the counter effect of existing social structures on the development and re-shaping the natural environment. From this point of view, rural ecology could be considered as a part of sociology which has ecological approach. However, it is a branch of ecology at the same time.

Since the definition of ecology is best formulated based on the issues it studies at a given time and since the subject of rural ecology studies is limited to the examination of relations between man and his rural environment, we could hence consider it a part of human ecology. Human ecology is close to geo-ecology or agricultural ecology (agroecology), and social geography wherein a natural influence of biology is apparent in a specific research method. Human ecology studies specific relations existing between man and his surrounding environment, although the same relations are also studied by other scientific disciplines from various aspects, which include: biological, technical, sociological, economic ones, etc.

The goal of the study of human ecology is to establish a balance in nature and society, where social factors are playing a particularly prominent role.

Bearing in mind the previous definitions of human ecology, its origin and development, we may well say that it covers four basic topics:

- Environment
- Population
- Technology
- Organization

Such a definition of human ecology is closely related to human's close relation to nature and vice versa, and their interdependency.

THEORIES OF ENVIRONMENT PROTECTION

Industrial revolution and scientific and technical progress following it influenced the relations between man and nature. Pollution of the basic elements of the physical environment (air, water and soil) has reached alarming proportions. Successful provision of exponential economic growth counts on unlimited sources of energy and raw materials. However, the notion that the environment is jeopardized, and all required material and energy reserves are limited, inspires many scientists to come up with various ideas about how this ecological crisis can be solved. This is how theories and proposed models for seeking solutions to this crisis come into being. Theoretic considerations of ecologic problems include economic growth, technical progress, population growth and their related consequences. Numerous opinions, philosophical and economic theories and movements are being formed. Approaches to the above stated problems are different depending on the country in which they originated; thus we have a number of different conclusions, assessments and proposed measures and models for their solution.

All the theories being emerging so far have been trying to find partially a way out from complex situations the modern civilization found itself. Yet, the overall problem in all its aspects can only be perceived through a synthesis of all these theories. Therefore, there is a need for an interdisciplinary approach to this problem. Most theories were established by individual economic branches, as, for example, in the agriculture, industry, communications and transport while some of them are more closely related to demographic problems.

Malthusian Theory - Malthusian theory was named after the Anglican clergyman and economist Thomas Robert Malthus, who in the early 19th century defined the so-called principle of absolute overpopulation. The essence of this „*principle*“ consists of the following: population expands faster (geometric progression) while production expands slowly (arithmetic progression) which inevitably leads to a discrepancy between the population numbers and means of subsistence. A balance between the population size and food production must be established in order that humanity survives. War is one of the key ways of establishing such balance as it slows down the population growth rather than production. Therefore, war is the effect of „*the principle of absolute overpopulation*“. This is why Malthus recommends marriage in the later years of life, sexual abstinence, birth control in the working class and other lower social strata. The origin of poverty,

according to this theory, lies in overpopulation and „*natural*“ principles rather than in social relations.

Theory of „Silent Spring“ - In the fifties of the twentieth century, there was great interest in and readiness for applying the new efficient inventions – chlorinated hydrocarbons, primarily DDT for the purpose of increasing yields the agriculture. They had the power of mass destruction of plants and other types of pests. The effects of the application of these harmful matters on air, water and soil, as well as their devastating effects on the natural world were not considered at all. The book *Silent Spring* by Rachel Carson (1962), by drawing attention to this phenomenon, played a key role in raising ecological awareness of the public of that period.

Theory of “The Costs of Economic Growth”(Marginal Benefits) - It first appeared in 1967 and was named after the book *The Costs of Economic Growth* by Mishan (Ezra J. Mishan), an English economist, which questions the overall purposefulness of further economic growth. The author advocates a stable economy while paying attention to the maintenance of environment quality and points out that in the manufacturing and price formation of any product, nobody takes into account any harmful effects (pollutions) occurring in an environment as a consequence of production, due to which any further pushing of the economic growth policy in developed capitalistic countries will probably end up with decline rather than increase of social well-being.

Theory of the Limits to Growth (Global Balance – Zero Growth) - In Rome, in the early seventies, precisely in 1968, a group of economists, sociologists, genetic experts, politicians and managers of some large world research centers founded the renowned Club of Rome. Their original position was that the issues of environmental pollution and rapid demographic growth have a global character therefore, the battle for a better environment cannot be fought partially at the level of individual nations, but solutions must be sought for at the global level. Two reports stand out within this theory. According to the first one – the conclusion is that the ecological crisis leading to ecological catastrophe can be avoided, and that other variable elements within the system can be kept under control only through a reduced birth rate and drastically limited production of food, if necessary.

The second report points to the fact that economic growth exhausts natural, mineral and energy reserves, and thus their provision requires investment of capital. The consequence is a rapid decrease in food production. Contrariwise, the population grows exponentially. Should the growth continue at the same rate, a crisis of catastrophic proportions would appear around 2020, mostly due to the level of environmental pollution, which would not be able to overcome by natural means.

MILLENNIUM ECOSYSTEM ASSESSMENT

The Millennium Ecosystem Assessment (MA) was called for by the UN Secretary General Kofi Annan and presented in 2000 as a part of his report to the UN General Assembly, *We the peoples: the Role of the United Nations in the 21st century*. After that, the governments supported the establishment of the millennium assessment through decisions passed by three international conventions so that the MA has started in 2001. The MA was conducted under the auspices of the United Nations, where the Secretariat was coordinated by the UN Program for Environment while the assessment was managed by a mixed body consisting of all stakeholders, to include representatives of the international institutions, business and non-government organizations and local population.

The objective of the MA was to assess the consequences of ecosystem change for human well-being, as well as to establish the scientific basis for actions needed to enhance preservation and sustainable use of ecosystems and their contribution to human well-being. The MA's conceptual framework assumes that humans are the integral part of ecosystem and that a dynamic interactive relationship exists between them and other parts of the ecosystem where variable human conditions drive the ecosystem changes both directly and indirectly, thus leading to the change of human well-being.

The report is a synthesis and integration of the findings made by four working groups of the MA:

- I - Conditions and Trends;
- II - Scenarios;
- III - Responses (measures); and
- IV - Sub-global assessments.

However, it does not provide any detailed overview of the reports of each working group; therefore the stakeholders are encouraged to make separate reviews of their conclusion by themselves. This synthesis is organized around essential questions that were initially raised for this assessment: How did ecosystems and their functions and roles change? What caused these changes? What was the impact of such changes on human well-being? In what way the ecosystems could change in the future and what the consequences for the human well-being would be? What are the possible options for enhancing the preservation of ecosystems and their contribution to the human well-being? Some of the MA's findings will be used partially in this book.

Summary of Some of the Global Ecologic Events through History	
Year	Event
1962	<i>Rachel Carson published a book <i>Silent Spring</i>, in which she analyses the relationship between toxicology, ecology and epidemiology and identifies a catastrophic harmful effect of pesticides on the environment. Carson triggered the ecological avalanche with this book.</i>
1963	<i>Beginning of the International Biological Program – a ten year program for exploring environmental damages, as well as their biological and ecological mechanisms, which laid the scientific foundations for environmentalism.</i>
1967	<i>The UNESCO International Conference on the Rational Use and Conservation of Biosphere opened discussions about the concept of sustainable development.</i>
1968	<i>Paul Ehrlich published a highly influential book entitled <i>The Population Bomb</i>, which explains the relations between human population growth, exploitation of resources and environmental policies.</i>
1969	<i>The first ecological NGOs established in the USA – Natural Resources Defense Council and Friends of the Earth, as well as the first governmental agency for environment protection - Environmental Protection Agency (EPA).</i>
1971	<i>OECD established the principle according to which polluters are obliged to pay for damages;</i>
	<i>The International Institute for Environment and Development (IIED) established in Great Britain;</i>
	<i>The Greenpeace Organization established in Canada.</i>
1972	<i>Stockholm hosted the UN Conference on Human Environment, which addressed the phenomena of regional pollution and acid rains. The Conference led to the establishment of numerous national agencies for environment protection, as well as the UNEP (The United Nations Environment Programme);</i>
	<i>The first national "green" political party was established in New Zealand;</i>
	<i>The Club of Rome published the famous and controversial report entitled <i>Limits to Growth</i>;</i>
1973	<i>The European Environmental Action Plan was published as the first document for the synthesis of environmental policies in EU.</i>
1977	<i>The United Nations held the Conference on Combat Desertification.</i>
1979	<i>The Convention on Long-range Transboundary Air Pollution adopted.</i>
1980	<i>Jimmy Carter signed the Global 2000 Report, which for the first time recognizes biosphere diversity as a critical feature for the functioning of the planetary ecosystem.</i>
1982	<i>The UN Convention on the Law of the Sea adopted; it includes environmental standards and regulations pertaining to the protection of the maritime environment from pollution.</i>
	<i>The prestigious World Resources Institute was established;</i>
	<i>The World Charter for Nature – United Nations was adopted; it considers each form of life as unique and principal value to mankind and calls for understanding the humans' dependence on natural resources and the necessity for a better control of their exploitation.;</i>

Summary of Some of the Global Ecologic Events through History	
Year	Event
1983	<i>The World Commission on Environment and Development (WCED) was established.</i>
1985	<i>At the meeting of the World Meteorological Organization held in Australia, the UNEP warned about the detrimental effect of CO2 and other GHG gases on global warming of the Earth;</i>
	<i>The Antarctic ozone hole was discovered.</i>
1987	<i>The Montreal Protocol on Substances that Deplete the Ozone Layer was signed.</i>
	<i>The UN World Commission on Environment and Development (WCED) published the study entitled Our Common Future also known as the Bruntland Report, which through a linkage of social, economic, cultural and environmental issues and global solutions defined and popularized the term sustainable development.</i>
1988	<i>The Intergovernmental Panel on Climate Change (IPCC) was established to synthesize most recent scientific, technical and socioeconomic research findings on climate changes.</i>
1989	<i>The prestigious Stockholm Environment Institute was established.</i>
1992	<i>The UN Conference on Environment and Development (Earth Summit) was held in Rio de Janeiro, which adopted: Agenda 21, Convention on Biological Diversity, Framework Convention on Climate Change, Rio Declaration and Forest Principles.</i>
	<i>The Earth Council was established in Costa Rica – to coordinate implementation of documents from Rio de Janeiro.</i>
1994	<i>ISO 14001 standard was accepted as a voluntary international standard for corporation environmental management systems.</i>
1995	<i>The WTO (World Trade Organization) formally recognized relations between trade, environment protection and development;</i>
	<i>In Copenhagen, the World Summit for Social Development identified for the first time the necessity of combat against absolute poverty.</i>
1997	<i>The Special Session of the UN General Assembly (Rio +5) identified little progress in the implementation of the Agenda 21 and adopted the Program for its further implementation.</i>
	<i>The Kyoto Protocol was signed as the UN framework convention on climate change. This document obliges underdeveloped countries to reduce emission glasshouse house" gases and determined "clean development" mechanisms for developing countries.</i>
1999	<i>Mass anti-globalization protests of non-government organizations held in Seattle.</i>
2000	<i>The Earth Day Network marked the 30th anniversary of the original Earth Day;</i>
	<i>The World Commission on Dams voiced its skepticism about further construction of huge dams and offered alternatives to big hydro-power plants.</i>
2002	<i>The Earth Summit on Sustainable Development was held in Johannesburg (Rio + 10). The Summit set a number of objectives that will lead to reduced inequality by 2015;</i>
	<i>EU ratified the Kyoto Protocol</i>

Summary of Some of the Global Ecologic Events through History	
Year	Event
2003	<i>192 members of the World Health Organization adopted the first public charter on harmful effects of smoking on human health.</i>
2004	<i>EU established and published the first registry of polluters in EU countries and completed its third report on the status of environment in Europe.</i>

2. CHARACTERISTICS AND ASSESSMENT OF BASIC ECOSYSTEM ELEMENTS

The concept of ecosystem was first introduced in ecology by English scientist Sir Arthur Tansley (1935), methodologically and conceptually determined by Lindeman (1942) and its final adoption was largely endorsed by books: *An Outline of General System Theory* (1950) and *Fundamentals of Ecology* (Eugene P. Odum, 1953). The term is coined of two words: *oikos* – Greek word for house, habitation; and system – organization, ordered structure. In modern time, there are various definitions and understandings of ecosystem.

According to Gilpin (1976), ecosystem is a natural complex of plant and animal populations and the particular sets of physical conditions under which they exist. These are organisms of a specific location, combined with functionally interdependent elements of the environment. Ecosystem is a single entity.

The Convention on Biodiversity (1992) – defines ecosystem as a dynamic complex of plant, animal and microorganism communities and their biotope (abiotic environment), interacting as one ecological whole. Harms (1994) considers ecosystems as dynamic communities of plants, animals and microorganisms and their biotope that are interdependent in a functional, widely self-regulating unity, and at the same time a part of large natural cycles.

Odum (1986) describes ecosystem in the following way: *“Living organisms and their nonliving (abiotic) environment are inseparably interrelated and interact upon each other. Any unit (a biosystem) that include all the organisms that function together in a given area interacting with the physical environment so that a flow of energy leads to clearly defined biotic structures and cycling of materials between living (biotic) and nonliving (abiotic) parts. This is an ecological system or ecosystem.”* The four fundamental laws of ecosystem were defined by Commoner (1972, 1979):

- I law: Everything is connected to everything else, everyone influences everyone else, everything influences everyone
- II law: Everything must go somewhere
- III law: Nature knows best.
- IV law: There is no such thing as a free lunch (You have to do something in order to get something in return).

There are many criteria for determining ecosystems: production, energy, economy, location or other. Practical subdivision of the ecosystem is usually made based on: origin, habitat, vegetation and human impact (Đukanović, 1996):

- With regard to their origin, ecosystems can be natural (original, untouched or wild) and cultural (partially or fully anthropogenic)
- With regard to their habitat, ecosystems can be terrestrial, aquatic and pelaeal.
- With regard to vegetation, ecosystems can be forest, grassland and wetlands.
- With regard to human influence, ecosystems can be either unchanged or anthropogenized (fully or partially changed)

Within ecosystems there are three categories of relationships, as follows:

- Actions include any effects that biotope (abiotic-physical environment), as a complex of external ecological factors, has on biocenosis.
- Reactions represent the effects that biocenosis make on the physical environment. Actions and reactions alter both components of ecosystem: biotope and biocenosis.
- Co-actions are the categories of similar relations and include all mutual relations existing among the organisms, members of biocenosis.

In order to get properly familiarized with the complex dynamic relations existing within an ecosystem, it is necessary first to learn about ecological hierarchy (Table 1).

Table 1: Ecological hierarchy

Unit (organism)	Fundamental unit of ecological hierarchy
Population	A group of individuals of one species inhabiting the same region at the same time and exchanging genetic material producing fertile posterity
Biocenosis	A community of plant and animal species inhabiting a specific area (biotope) and mutually related by various types of interactions and food chains. The community is often defined as a collective of all organisms occupying a specific area or biotope.
Habitat	A complex of abiotic and biotic factors– environment. The place where an organism lives.
Biotope	Biotope represents the abiotic component of ecosystem; a physical space occupied by one community – physical environment. A part of physical space characterized by specific complex of ecologic factors.
Ecosystem	A system that integrates organisms (biocenosis) and their physical environment (biotope) into a uniquely interrelated whole.
Biome	A large complex which covers entire geographic regions. Biomes are distinctive by dominant vegetation relating to a specific type of climate.
Biosphere	Thin superficial layer of the Earth’s crust which holds life. The highest level of integration of the entire living world and its physical environment, into a single, functional and extremely complex dynamic system.

ENVIRONMENT – A COLLECTION OF ECOLOGICAL FACTORS

In everyday life we often contrast living to nonliving, organic to inorganic, biochemical to physical, while in reality, these two opposite phenomena of the natural world are not isolated from one another. Living and nonliving worlds co-exist in a complex relationship of interdependence. The life of organisms is totally dependent on their physical environment, but, on the other hand, organisms also affect the abiotic world.

Within an ecosystem, there are factors upon which depends the life of organisms inhabiting that space. All the components of environment that have an impact on the living organisms are called **ecological factors**.

Ecological factors are divided into abiotic and biotic groups:

- **Abiotic** (nonliving factors):
 - On land – climate, relief and soil
 - In water - water mass movement, salinity, penetration of light
- **Biotic** (living factors) – organisms and their mutual relationships: predation, competition, parasitism, mutualism, etc.

Characteristics of ecological factors are as follows:

- Dynamic and ever changing in intensity, quantity and the way of action;
- They never act individually, but collectively as a complex of factors, may be replaceable and irreplaceable;
- May act directly or indirectly via other factors; and
- They are called the factors of survival if essential for life of organisms.

An important property of ecological factors pertains to their changeability in time and space. Any organism reacts to such changes through a specific ecological adaptation. **Ecological valence** represents the amplitude of oscillation (from minimum to the maximum) of a specific factor within which survival of a species is possible. Most suitable conditions for a specific species within a given ecological factor represent the optimum.

Different plants show different ability to adapt to the conditions of the external environment, i.e. show different ecological valence. Eurivalent (*eur* – wide) organisms show a higher ability to adjust (more easily) to various ecological con-

CHARACTERISTICS AND ASSESSMENT OF BASIC ECOSYSTEM ELEMENTS

ditions then stenovalent (*steno* - narrow) organisms. Eurivalent cultivated species include wheat, barley, oats, potato, apple, pear and plum. Stenovalent plants are as follows: maize, millet, buckwheat, tobacco, sugar beet, alfalfa, melon, grape, olives, figs, tangerine, apricot, peach, etc.

As stated above, environment is a complex of ecological factors that act as a whole and to which an organism responds as a whole. According to the Law of the Minimum (Liebig, 1840) the factor that is closest to the minimum determines the chance of one species' survival and prosperity, though all other factors may be within the optimum or close to it.

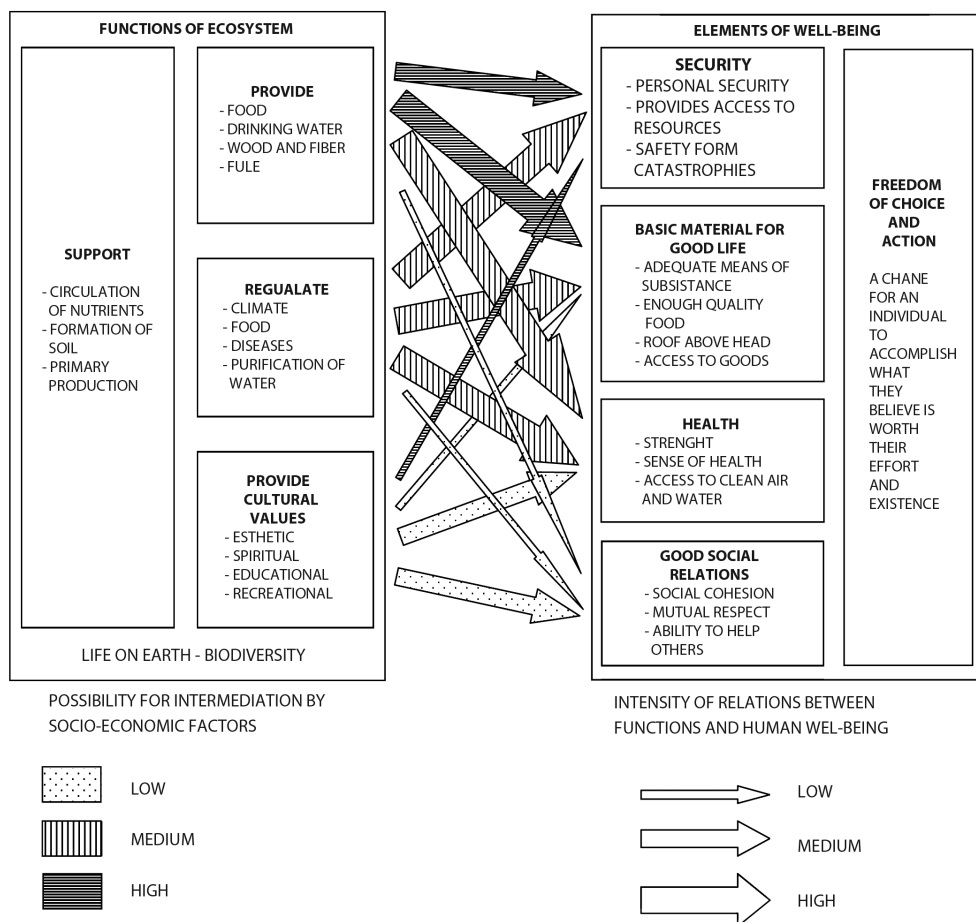


Chart 1: Linkages between Ecosystem Services and Human Well-being (Millennium Assessment Ecosystems)

TERRESTRIAL ECOSYSTEMS

According to the vegetation type, the most significant terrestrial ecosystems include as follows: agricultural, forest, grassland ecosystems as well as wetland and marshes. The key to a better understanding of environment, in these ecosystems, is knowledge of their biotic and abiotic factors.

ABIOTIC FACTORS

Climate and Relief

The Earth's climate is determined by the quantity of absorbed sun energy and its distribution across the planet. The Sun's shortwave radiation penetrates the atmosphere and gets absorbed by the Earth's surface. When land and water get warm they emit heat into the atmosphere, but in this case as long wave (thermal) radiation. The atmospheric gases (water vapor, carbon dioxide - CO_2 , methane - CH_4 , ozone - O_3) absorb one portion of this radiation and direct it back to the Earth, and this effect is well known as the greenhouse effect. The gases thus become warmer, and though the Earth's radiation ultimately escapes into space, it still stays long enough to cause warming of the atmosphere. Without this effect, temperature on Earth would be lower by 30 - 40 °C.

As the Earth's surface cover varies (bare rocks, sea, forests, etc.), hence its ability varies to absorb sun radiation creating diverse levels of warming and cooling patterns on its surface. White and smooth surfaces reflect light and heat whereas black ones absorb them. The percentage of sun light reflection and heat from the Earth's surface is called albedo. The highest albedo coefficient has snow (0,75-0,90) and white clouds (0,70-0,90). The broad leaved forests absorb heat the best (albedo 0,10-0,20). Conversion of forests into arable land increases the albedo by about 10%.

Thermal energy absorbed by the Earth is emitted back into cosmos, but only after it has caused evaporation of water and triggered the processes of atmospheric and oceanic masses circulation. All these factors have created an enormous diversity of physical conditions of Earth, which ultimately enabled the biome diversity.

The seasonal temperature fluctuations decrease as we move away from the equator. In the same way, distribution of vegetation cover becomes different too. The climate diagram represents a pragmatic method of examining the relations between distribution of terrestrial vegetation and climate. Charts for the classification of plant communities on land (types of vegetation) are based on temperature and humidity (precipitation) of the area.

Variations in topography and geology may cause variations in the environment within an area with uniform climate. In mountainous regions, for example, the terrain inclination and exposure to sunlight have influence on soil temperature and humidity. The air temperature decreases with altitude by approximately 6 °C for every 1000 m. In the northern moderate geographic altitudes this temperature drop of 6 °C corresponds with the change of temperature which occurs with the increase of geodetic altitude by 800 km. Spatial variations in the soil underlying parent rock, relief, vegetation cover and climate cause differentiation of various soil types, being one of the most significant elements of terrestrial ecosystems.

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Bosnia and Herzegovina is a hilly and mountainous country of pronounced geomorphology with predominant mountainous ecosystems - 42%, karst - 29%, hilly terrains - 24% and flatland - 5%. It is rich in diversified ecosystems: agricultural, forest, grassland, aquatic, wetland, spelaeon, etc.

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Land/Soil

Land or soil is loose surface layer of the Earth's crust wherein the living (biosphere), and nonliving elements (lithosphere, hydrosphere and atmosphere) cross their paths and create a new single sphere called pedosphere. This is a complex dynamic unit, in which various processes and changes continuously take place and thus creating different types of soil.

The soil is composed of three phases: solid (mineral and organic part), liquid (soil solution) and gas phase (pore space) that create the so-called three-phase system. These phases are mutually distributed in the way which gives soil the attributes of porous and loose rather than a compact mass. Pores are the environment of the plants' root system and other soil inhabiting organisms.

The formation of soil requires certain factors and processes. The factors relevant for soil formation include parent substrate (parent rock), climate, organisms, relief and time. The pedogenetic activities (soil formation processes) are divided into three basic groups:

- Decomposition of primary minerals (parent rock) and synthesis of clay minerals,
- Decomposition of organic residues and synthesis of humus as a specific complex organic compound, and
- Migration of soil fragments through water and organisms in various directions.

The intensity of such processes varies depending on depth, wherein humus is usually accumulated in the superficial layer or migration and depletion through descending watercourses take place. Decomposition is more intensive at deeper layers; however, accumulation and enrichment with mobile substances may occur too. The effect of these processes is vertical differentiation of soil into horizons, all the way down to the bedrock.

Multifunctionality of land - The role of soil in natural and cultural ecosystems is not simple, but rather manifold and multi-valued. Some of the roles are hard to separate one from another if separable at all, while, contrariwise, others totally exclude each other. Some of the most relevant ecological roles of soil include:

- Production of organic matter in agriculture and forestry,
- Ecological and regulative function,
- Soil as a source of genetic abundance and protection of biological diversity (biodiversity),
- Function of soil in space, and
- In archeological researches.

The provision of plants with water, air and mineral matters enables production of biomass (organic matter) in the process of photosynthesis. In this sense, the role of soil is indispensable in sustaining life on Earth, i.e. plant production in primary activities such as agriculture and forestry. Through the production of organic matter in agriculture and forestry, man manages to fulfill both "dietary" and "non-dietary" requirements such as food, drinks, beverages, energy, fibers, medicines, spices, raw materials for wood and food processing industry, hides and furskins industry, etc.

The key ecological and regulative roles of soil are as follows:

- Soil as a receiver – accumulator, transformer and medium for transferring of various materials;
- Soil as a filter for water, whose filtering activity is determined by its adsorption capacity via colloidal complex;
- Soil is also a universal buffer, i.e. it has the ability of attaching and inactivating harmful matters, which is a variable and limited value;
- Soil has a climate-regulative role, especially through the impact of agriculture on the carbon cycle and other gases that induce the so-called "greenhouse" effect; and
- During the process of photosynthesis, forests and agricultural crops consume atmospheric CO² while releasing oxygen, thus reducing the "greenhouse" effect.

Soil is the habitat and genetic reserve of numerous micro and macro organisms, i.e. pedoflora and pedofauna. A biologically active soil providing biological diversity is fertile soil. The soil life (flora and fauna soil) creates and improves ecological services:

- Creation and conditioning of soil; invertebrates (earthworms, ants) decompose plant waste and create conditions that allow circulation of nutrients, oxygen and water in nature;
- Removal of waste materials; microorganisms (bacteria and fungi) reduce organic waste to elemental nutrients and detoxify ecosystems;
- Stabilization of soil; invertebrates and microorganisms influence physical, chemical and biological properties of soil playing a key role in protection against erosion and flooding;
- Storage (sequestration) of carbon; larger biomass and diversity of microbial populations in organic systems contributes to the capacity of soil to retain carbon, i.e. reduce its emission into the atmosphere where it causes the greenhouse effects;
- Nitrogen circulation; soil gets enriched with nitrogen from the atmosphere through the process of fixation by rhizobia that live in symbiosis with legumes roots that need to be introduced in crop rotation;
- Symbiosis and parasitism; symbiotic organisms (rhizobia and mycorrhiza) play a crucial role in the absorption of nutrients and reduce the invasion of pathogens. Parasitism is used in biological control of insects;
- Predators; rivalry between predators and pray keeps pests under control.

In addition to the foregoing, it should be stated that soil plays an important role in the shaping and appearance of landscape as it determines the methods of use of space, as well as a source of raw materials for the production of bricks and tiles in ceramic industry, exploitation of sand and gravel, or exploitation of wood, etc.

The soil is also important in terms of historic media since it contains conserved archeological artefacts and paleontological materials used to reconstruct geologic development of a certain area, and it serves as a source of information on historic events, which gives it a cultural role too.

Each of the above stated ecological roles of soil either individually or collectively emphasize soil as one of the most important elements in the overall functioning of terrestrial ecosystems. Likewise, soil management in agriculture and forestry, as well as the attitude towards soil in general, represents a challenge to every society.

Valorization of land factor – All roles of soil within sustainable management are essential, not just those related to food production and profit generation. One of the inevitable tasks of contemporary agriculture is to manage the land in a sustainable way. Decisions pertaining to the land management method make a considerable impact on the functions and sustainability of natural ecosystems. The sustainable land management results in improved soil fertility and reduced negative impact of human activities on the performance of soil ecological functions and soil contamination.

When it comes to decision-making in the area of land use and type of land use, valorization of land factor, being one of the basic elements of ecosystem stability, represents the first step in the overall assessment of any ecosystem, and especially of the agricultural one. Physical, chemical and biological properties of the soil expressed through the ecological parameters most directly determine the role of soil in the performance of complex ecological functions.

The most significant ecological parameters of soil include terrain slope, soil texture, soil depth, total CaCO_3 , soil reaction, content of soil organic matter and base saturation levels.

The *terrain slope* is one of the key ecological factors. The steeper the terrain, the smaller selection of crops and exposure of land to erosion is more prominent.

The *soil texture* (percentage representation of rocks, gravel, sand, dust and clay) is one of the most stable properties that have a direct impact on the soil's water-air and thermal regime.

The *soil depth* is one of the most significant properties since deep soil depth reduces the negative impact of adverse soil characteristics and increases positive impact of the favorable ones.

The significance of *total CaCO_3* stands out particularly in relation with soil reaction (buffer effect), as well as inactivation (transformation into forms inaccessible to plants) of phosphates and iron in neutral and alkaline soils.

The soil reaction indirectly impacts the yield of cultivated plants. The majority of agricultural crops benefit from slightly acidic to neutral pH reaction of soil which provides for the fastest and most quality transformation of organic matter and thus formation of quality mature humus.

The *soil organic matter* (whose main constituent is carbon with 57%) is one of leading soil quality indicators in ecological functions of soil. There are two main reasons for that: first, organic matter influences the soil fertility (by improving the soil structure, absorption of water and nutrients, but itself is a source of nutrients that are released in the process of mineralization); second, it has an environmental

aspect, i.e. its climate regulative role being the largest terrestrial reservoir of carbon which is contained in soil in the form of organic matter.

The *base saturation adsorption complex* is an important soil parameter that is often neglected even by agricultural experts. A soil whose adsorptive complex is saturated with Ca^{2+} and Mg^{2+} has neutral reaction and is most suitable for the life of cultivated crops. The information on the composition of adsorbed soil cations indicate the direction of soil improvement. In acid soils containing adsorbed H^+ and Al^{3+} calcination (calcification) is usually performed where they are substituted by Ca^{2+} . The soil adsorption complex is storage of nutrients for plants. The soils, whose adsorption capacity of cations is small, cannot be treated with higher amelioration doses of mineral fertilizers (due to leaching effects). Soils with high saturation by H^+ ions in adsorption complex must not be treated with physiologically aciduous fertilizers (sulphates).

AGRICULTURAL ECOSYSTEMS

Nowadays, the agrosphere is receiving more attention. The agrosphere is a part of the rural space on land in which agricultural production takes place. In order to satisfy his needs, man had taken a part of free and wild nature and started to grow field crops and keep domestic animals. In a deliberate and planned manner man started to organize plant production. The conversion of natural forest and grassland into agricultural land is actually a change of land use method and is called cultivation. The agricultural production space has gradually expanded over time mainly in the regions having favorable conditions for human living and production of food. By creating the agrosphere, i.e. cultivation of land and plant growing, man made a huge intervention in biosphere (nature) and started to change it in a way which suited him best. Once the agricultural production space is abandoned, it gradually becomes a part of the free nature again.

The elements of agricultural production space are as follows:

- **Agro-biotope**, agricultural physical environment consisting of soil, relief and climate
- **Agrobiocenosis**, agricultural biological community consisting of:
 - agricultural production complex, representing primary biological communities (cultivated plants, domestic animals and humans) accompanying complex, which include:
 - harmful members of agrobiocenosis such as weeds, insects, plant pests, mice, birds, rabbits...

- beneficial members such as honey-bees, bumble-bees, silkworm, birds, worms, bacteria, nitrogen fixation agents,
 - some of the members of these communities may be both harmful and beneficial.
- **Agrosynusia** (agricultural synusia) are narrow biological communities within an agricultural production space. They occupy a small or large part of agrobiotope, i.e. agrobiocenosis. Such communities with specific characteristics are for example plough land, garden, orchard, vineyard, grassland, etc.
 - **Agroecosystem** (agricultural ecological system). The agricultural ecological system is a complex, but harmonized association of agrobiocenosis and agrobiotope. On one hand, it has strong mutual relationships and influences between land, relief and climate, and the accompanying complex on the other.

Agroecological factors - vegetation factors operate in the agricultural production on which depends the life of organisms of that space. The environment represents a collection of all ecological factors. Agroecological factors may be:

- internal (pertain to the hereditary features of a given species or individual)
- external (pertain to the external environment in which that organism grows)

The external factors are further subdivided into:

1. Non-living or abiotic factors including:
 - climate (light, heat, precipitation, air, wind),
 - soil (soil type, depth, texture, structure, content of nutrients, humus, pH, moisture, etc.), and
 - relief and all of its forms (elevation, inclination, exposure, etc.)
2. Living or biotic factors, which include:
 - insects, pests,
 - weeds,
 - soil organisms,
 - wild and domestic animals, and
 - particularly significant impact on humans.

The living conditions in an agrobiotope affect the composition and productivity of its agrobiocenosis. Any crop changes under the influence of environmental factors and in accordance with them, but at the same time the crops change, to a certain extent, the external conditions of their environment. If the climate, relief and soil in an agrobiotope are not suitable for plant production, such agroecosystem is not stable; hence the production is risky in it.

Agroecological Zoning (AEZ)

Using scientific methods in agriculture and environmental protection it is necessary to analyze clearly all aspects of multifunctional role of agriculture and land in different agricultural areas. Depending on the outcome, it is necessary to create socially, economically and ecologically acceptable systems of crop farming, animal husbandry and land management. This requires comprehensive interdisciplinary researches and scientific examination of all aspects of land management.

Based on *the land use* (use of land areas) method there are agricultural land, forest land, grassland, urban areas and water surfaces. On the other hand, *the type of agricultural land use* represents a specific agricultural production under a certain crop or plantation. It depends on abiotic factors: on one hand, on relief (inclination), soil fertility and climate and up to socio-economic characteristics of a certain area (vicinity and level of development of communications, urban areas, size of farms, traditional agricultural activity, age of the household, religion, ...) on the other hand. Based on these factors the types of agricultural production, i.e. investment levels are defined as follows:

- Biological production – modest level of investment
- Traditional extensive way of production – medium level of investment
- Intensive way of production – high level of investment, and
- Highly intensive way – high level of investment

Agroecological zoning (AEZ) represents a methodology for defining the suitability of a certain land area for a certain type of agricultural production, through different phases. The AEZ model is used to identify specific limitations to growing agricultural crops in specific climate, soil and relief conditions, and, in some cases, even the conditions related to investments and managing. This means that within the scope of fully defining a type of land use it is necessary to define the plants' requirements for abiotic factors (climate, relief and soil).

The climate related requirements include total precipitation during the vegetation period, duration of the vegetation period, duration of no frost period, total temperature in the vegetation period.

The relief related requirements include inclination and altitude. The soil related ones include depth, content of nutrients and organic matter, pH value and level of toxic matters.

It is possible to define classes of soil suitability for a specific agricultural production, as well as to group land areas into agroecological zones based on the outcome of the analysis of agroecological factors and plant requirements. This way provides the most suitable method of soil utilization in any given agroecological and socioeconomic conditions, which is a key prerequisite of sustainable agriculture.

Spatial zoning like AEZ provides its users with quick and very specific information as to what could be produced on a certain agro-biotope. Such approach also allows development of various policies and passage of plans for development of municipalities, cantons or regions. It is possible to define priorities in the area of development programs and sustainable agricultural development using these tools, all in accordance with the environmental programs for land protection and use.

These are, of course, just the guidelines or planning tools, which must be linked with the socio-economic aspect of the territory, as the capacity of the territory is one thing, whereas desires, requirements and visions of the population, especially direct beneficiaries – farmers, are entirely another thing. If these two aspects are linked, investments are going in a good direction.

Types of Agricultural Ecosystems

Today, about 35% of the Earth's land area is used for agricultural purposes, and it is estimated that more than 2 billion people are involved in this activity. Historically speaking, ever since the very beginning of agricultural production, its every change aimed at meeting the increasingly growing demands for food, has inevitably caused social changes as well as ever bigger transformations of natural ecosystems. They reflected on the emergence of new agricultural landscapes at the expense of natural grassland and forest areas, as well as in the formation of a new „agricultural ecosystem“ with all its specific features.

There was also a change in the animal world along with the change of floristic composition in agroecosystems, where certain wild species lose their natural habitats or parts of them forcing them to migrate and adapt to the changed conditions. Wild species are now in agroecosystems replaced by domestic animals. On Earth, there are more than 2 million of plant and animal species of which only about 200

plant species are cultivated and used as food, and about 30 animal species. It can be stated that agricultural ecosystems are rather poor compared to the natural ones.

The agricultural ecosystems and agricultural landscape are different in different parts of the world, e.g. terraced rice fields in eastern Asia, flat prairies on the American continent, agricultural areas with extensive production in developed European countries, arid areas in Africa with nomadic type of animal rearing that has not changed for centuries.

If we look into the distant past, the hunter-gatherer way of life was the oldest form of exploiting natural ecosystems by humans. It was the only way of providing food for entire population until the emergence of agricultural production. We could say that nomadic groups at the time were equal members of natural ecosystems in the sense that their impact on environment, i.e. utilization of natural resources did not distinguish them from any other species. Such way of life can still be found only in some remote parts of Amazonia and in the Arctic zone among the Eskimos.

As for the emergence of agriculture, its earliest forms were nomadic. This means that after the natural soil fertility got exhausted in an area through crop production or animals had no more grassland to graze on, the nomadic tribes would move to new regions with fertile soil and new grassland. Nomadic agriculture is still employed in some areas with either harsh climate or shallow and low fertility soils.

Humans began to practice sedentary agriculture in the 9th or 10th millennium BC. Agriculture was able to provide up to a few dozen times the amount of food on one hectare of land compared to hunting and gathering, which created also prerequisites for demographic growth. The emergence of sedentary agriculture is associated with the abandonment of nomadic way of life and appearance of the first permanent settlements, i.e. the emergence of civilized society. The history hence begins with the emergence of agriculture. It began in early Holocene, the warm geologic period which succeeded the last ice age, in the Middle East region which at the time was rich in grass. Simply said, agriculture evolved through two branches: growing of domesticated/bred plants and rearing of domesticated animals. Certainly the most relevant among plants are the bred grasses currently known as grains, and among animals domesticated and bred cattle and sheep, which again use grassland – pastures as a primary source of food. The examination of DNA of various lines of einkorn wheat (*Triticum monococum*) and their cross-referencing show that all the lines descend from one common parent whose characteristics are closest to the wild lines found on this territory in the vicinity of the town of *Diyarbakır* (town in the southeast of Turkey). Similar situation is with European cattle whose place of origin is undoubtedly Middle Eastern (Middle Eastern aurochs) and whose domestication ran separately and parallel with domestication of Indian aurochs. Where grass is, there is life (Kuk, 2007).

Current agriculture is mainly sedentary and involves parcelised (by family estates) agricultural areas. Such parcelised areas have become a trademark of agricultural landscape.



Picture 1. Rectangular parcels (Ljubinje)

In the beginning, the production was oriented toward meeting the needs of one household in food and other supplies on family households being actually mixed farms with integrated plant and animal production. The agricultural areas within family households were small, about 1-2 ha, which have remained to the present day in many countries posing an enormous limiting factor to competitive agriculture. The yields on family farms compared to large commercial farms are considerably smaller due to smaller investments and bigger share of human labor. The modern day agriculture, particularly in developed countries, is market oriented (profitable) and mostly specialized in production of just one crop (monocrop) or that of one animal species. The biggest modern profitable farms in Australia and North America manage the agricultural areas of approximately 100,000 ha.

Grains were the first cultivated crops and are still the most produced ones. The yields of maize, rice and wheat make up more than one half of the world's food production. Maize and wheat are mainly grown in a moderate zone and largest areas are situated in the American central plains, South-American pampas and moderate

region of Australia. The advantage of grains lies in their easy storage and keeping, as well as transport to far distances facilitating their availability worldwide.

Rice, along with maize and wheat, represents the world's most essential grain that originates from Asia where it has been grown for 5000 years. On the most part of 12 million km² under the rice fields worldwide, rice is grown on flooded terrain (terraces), where the seedlings are replanted right after the terraces have been ploughed and weeded. The flooded rice fields represent a significant source of emission of the glasshouse gas methane (CH₄).

Significant agricultural ecosystems of monocrop cultivation, on a world scale, are vast plantations of cotton, tea, coffee, cocoa, bananas, oil palms and sugar cane which exist since the colonial times. It is characteristic for warm and humid regions of Malaysia, Brazil, Mexico, India and Cuba. Their total area in the world amounts to approximately 8 million km². They provide jobs, housing, education..., i.e. all aspects of life to the local rural population.

Major forms of **animal husbandry** - animal rearing aimed at providing food for humans, include cattle, sheep and dairy farming. The world largest source of meat is cattle. Some cow species are reared only for milk production.

The vast and open areas that are less suitable for crop husbandry due to the limiting external abiotic ecological factors (climate, soil and relief) are usually selected for development of animal husbandry. Large areas intended for cattle farming are found in South America and Australia. In Africa, cattle farming had no chance to develop to a significant extent due to diseases such as cattle plague, which is transmitted to cattle by wild animals (antelope, buffalo and giraffe).

Expansion of livestock production in the tropics led to the deforestation of large forest areas causing serious damages to the environment at the global level, through the disruption in the carbon cycle. In addition, excessive grazing of large herds of cattle reared in arid (dry) regions disrupted natural balance in grassland ecosystems. Namely, as the grass vegetation in arid areas takes long to recover after grazing, the land remains bare and exposed to erosion.

In comparison to cattle (it is estimated that the daily requirement in water of one cattle head is 80 liters), sheep are much more resistant and have a higher tolerance to the extreme climatic conditions (heat, cold and drought). Around one billion sheep are reared worldwide, either on fertile pasture areas with developed commercial farms (which is the case in North-Eastern Europe), or on less fertile and arid, but large areas – as is the case in most parts of the world. Some sheep farms in Australia extend on the areas of 100,000 ha, which means that each sheep has about 20 ha of land to feed.

The most important animal species, when it comes to milk production, are cows, buffaloes and, to a lesser extent, sheep and goats. Only rearing of cows for milk can be economically feasible, though it requires high quality food. Dairy cows must be provided quality grazing in case of farming in the open, and quality forage in case of indoor farming.

Development of modern agriculture is nowadays based mainly on improvement of genetic potential of plants and animals, as well as on applied agrotechnical measures, and as a result the grain yields have been quintupled over the past 100 years. In this context, it is necessary to mention the so-called „**Green Revolution**“ – an international program for inciting agriculture which spread worldwide in the sixties of the last century. The green revolution encouraged the application of mineral fertilizers and protection chemicals in agriculture, which resulted in multiple increase of yield of agricultural crops to date. This program, though it provided more food and reduced risk of famine through increased yields, is still criticized for insisting on the application of chemicals. Some critics go even further and present the model of Green Revolution, which focused on satisfying the human needs rather than the implications of such practice on the environment, as an initial role model which was then followed by other human activities, thus causing uncontrolled exploitation of natural resources and degradation of environment.

The utilization of genetically modified organisms (GMO) created for the purpose of improving the resistance of cultivated crops to diseases and pests as well as providing more even and higher yields is currently considered in a similar context. Many stakeholders in agriculture, to include agricultural experts, believe that genetically modified grains may play the key role in combating famine worldwide, especially in the context of demographic explosion we are witnessing. GMO but also such attitudes are the source of many controversies. The opponents frequently claim that large corporations through the exclusive right to the production of GMO seed material will control the food production worldwide as well, which brings considerable insecurity in this area. On the other hand, human consumption of GMO food that is ever more present and significant in the human nutrition, is at the same time a global experiment whose results are uncertain due to insufficient and incomplete knowledge about long term effects of such food on human health.

The introduction of crop rotation in the agricultural production creates a type of production that is more flexible and safer than the monocrop one which is typical for large specialized commercial farms. The rotation of grains, fodder and arable crops in the sense of space and time, and in combination with animal husbandry production which provides manure for the application on arable land, is ecologically more acceptable form of agricultural production in comparison with the monocrop production. Today, such farms can be found in developing countries which, often

having their own seeds and planting materials, represent one of the safest types of agricultural production. The countries which purchase required food on the world market that is dependent on numerous factors not always related to agricultural production (wars, fuel prices, monopolies, different interests of exporting countries) or those which produce food through the specialized monocrop production generally have a considerably lower level of food security. One of the very good examples is Cuba, which used to be economically dependent on the Soviet Union for a longer period of time; after the dissolution of the SU, it was faced with the interruption of previously continuous and sufficient supply of energy and raw materials. This disruption was particularly detrimental to the specialized agricultural production in large socially owned holdings which, due to the shortage of fuel and protection chemicals, found themselves in a chaotic situation. As a result of such situation, Cuba was not able to produce enough food for its population. During those years, desperate population faced with food shortages and starvation, had no other choice but to resort to their own capacities. On a massive scale, they got involved in rearing domestic animals and growing vegetable crops in their house yards; some manage to lease the land previously owned by ruined agricultural combines and started to grow grains for their own consumption... All that reactivated using of proven and traditional breeds and cultivars. As a result of that time events, the modern time Cuban agriculture is least dependent on global processes related to the production and distribution of foodstuffs and is characterized by a high level of food security.

FOREST ECOSYSTEMS

The forests cover around 30% of a total land area, and they are one of the principal terrestrial ecosystems. It is believed that 1.6 billion people depend on forests and their surroundings. Forests are home to approximately 300 million people around the world.

The ecological functions of this ecosystem are numerous: it is the place for sprouting, growing and developing of plants; it provides food and shelter to many wild animals; it takes part in the cycles of water and carbon; it improves air, protects soil from erosion, regulates climate and microclimate... and it has an important place in the early stages of human society (hunter-gatherers stage). Today, forests are largely endangered by human activities such as felling in order to acquire new agricultural areas, building of roads and settlements, as well as obtaining timber.

Forests are normally defined by the predominant type of trees as deciduous or coniferous. Depending on geodetic latitude we distinguish dark coniferous forests (taigas); lush, mixed deciduous forests of temperate zones (500-1000 mm annual rainfall); and dense rain forests of the wet tropical zone (1000-2000 mm annual rainfall).

The coniferous forests are characteristic for the northern parts of America and Europe (taigas). Predominant species are spruce, pine and fir, and to some extent larch. Conifers are also typical for mountainous regions where they occupy the higher elevations, above the deciduous forests. The forest floor in conifers is less overgrown by plants as these forests are normally darker and they significantly reduce any light below the canopy while the shed needle-shaped leaves containing resin are forming acid soils. The evergreen forest used to cover large areas in the Mediterranean (from the Middle East to Spain, as well as along the North African coast), whereas now they are sporadic and scattered mainly due to anthropogenic impact.

A dense deciduous forest (oak and hornbeam) can be found in a temperate forest areas, like those in the Alps, in flatland and hilly forests; mixed forests are found in sub-mountainous areas, while coniferous forests (silver fir, spruce and larch) are found at highest elevations. Above 2000 m.a.s.l. there is no forest (climax line), only high mountain pastures and shrubbery. Interestingly, in the tropical region, between the mountain forest and shrubbery, there is a bamboo area.

Deciduous forests of the temperate zone of North America, Europe and Asia are broad-leaved, exuberant in the summertime, while in the wintertime, they shed all the leaves that fall on the forest floor. The shed leaves on the ground and fallen branches, bark and seeds form the organic layer on the surface which gradually decomposes (humifies) and mixes with the mineral soil thus creating a fertile substrate suitable for growing of the plants. As the spreading area of deciduous forests is densely inhabited and in the past the large areas of these forests were exposed to deforestation, they were converted with the aim of use in agriculture.

The temperate forests, thanks to their fertile soil, are habitat to a number of plant species and various invertebrates (among which dew-worms are the most significant) which digest organic residues from the soil surface, while their secretions mix well with mineral portion of the soil creating in that way an organo-mineral complex – one of the stabilizing elements of soil. Many forest birds (songbirds and tits) feed on insects and worms in tree tops. Foxes, badgers and deer belong to the group of large mammals whose habitats are within the temperate forests.

It is not uncommon for the forest trees to live up to several hundred years. Their life cycle ends with the tree dying and falling onto the ground, it decomposes like any other plant residues, leaving space for sunlight accelerating the growth of young seedlings and filling of the vacant position. Such a position may be created by a thunderbolt, disease stricken tree or trees, as well as by devastating winds or forest

fires which are often cause of a complete disappearance of large portions or even entire forests (in the ashes remained after the fire, a large number of seeds remain and germinate, producing new seedlings).

The South Andean, Central African, Madagascar's and Indonesian rain forests, along with the South American dry forests, represent one of the most important natural ecosystems on the planet. Rain forests are characterized by abundant rainfall (minimum amount of 1,750 – 2,000 mm/year) and high humidity. Rain forests in Southeast Asia are characterized by seasonal monsoon precipitation, while tropical forests in the Eastern parts of South America are dry (average precipitation is less than 800 mm/year). The rain forests have three distinctive layers of plants: the tallest „emergents“, the younger trees of medium height and the layer of dense scions and underbrush at the forest floor. Besides numerous species that live in the tropical rain forests, it is estimated that a few million species of plants, insects and microorganisms are still undiscovered. The Amazon rain forest with approximately 2000 mm of annual rainfall, is the largest tropical forest in the world (it covers 5.5 million km²). This is a 55 million years old ecosystem with around 13,700 endemic species. Local population uses around 2,000 plant species for different purposes (food, medicine, various articles, and accommodations). The rain forests of Congo are the richest in whole Africa – they have a total of 11,000 plant species (African mahogany) and around 400 species of mammals (African forest elephant). On the island of Madagascar, 80% of flora are endemic species while 95% of 300 reptile species are endemic, to include two thirds of all chameleons in the world. The Indonesian rain forests constitute 10 % of the world forests and are the richest habitats to over 500 mammals, 1,500 bird species, 1,000 reptiles and amphibians, and 20,000 plant species out of which 100 are trees.

In addition to rainforests, tropical region is home to mangrove forests which grow in tidal zone formed by high and low tide (muddy shorelines). A thin or sporadically wide strip of mangrove forest reinforces the shoreline and provides habitat to numerous mollusks, fish and swamp birds. These unique ecosystems are at risk of extinction due to increased felling of mangroves for lumber, but also to obtain areas for aquaculture (fishing and shellfish farming).

GRASSLAND ECOSYSTEMS

The areas covered by grass can be found in semi-arid areas, but also on flooded surfaces. Tundra is another grass biome which covers a large portion of land in the arctic zone. Though exposed to the adverse weather conditions, the grassland areas are considered to be one of the richest ecosystems on the planet. They are formed

on fertile soils with seasonal distribution of rainfall, where the vegetation season lasts from 120 to 200 days. The quantity of rainfall typical for this area is less than in forest zones, but still bigger than in the shrubbery or desert areas. The boundaries of grassland areas are continuously changing due to climatic volatility as well as conversion of grassland into agricultural land or pastures.

The grassland ecosystems of temperate zones (pampas in the southeast of South America, prairies in North America, open pastures of South Africa, or rangelands in southeastern Australia) are characterized by dry and warm summers and cold winters. Vegetation consists of permanent grasses. Most rainfall is received in spring, while fires spread by high winds are rather frequent. These frequent fires play an important role in the functioning of this ecosystem, as they burn grass remains creating ash which is nutrient for new plants.

Vast grass flatlands in North America are now transformed into grain fields. The only one percent of grassland areas is left on the hilly terrains. This area was a source of food to vast herds of buffalos, which were the main source of food to the native Indian tribes.

Tropical grassland areas or savannas widespread in Brazil, eastern and southern Africa, southern Sahara and northern Australia, are more diversified in terms of their characteristics. The grasses are reaching up to several meters in height. They are warm around the year and receive more abundant rainfall. In the vast grassland areas there are some natural shelters made of trees and bushes.

The grassland areas seem not to be inhabited by game animals since many animal species are either nocturnal or dwell under the ground (voles, moles, earthworms, bugs and other invertebrates). Many herbivores developed the ability to move fast (ostrich, gazelle, hare), or live in flocks in order to defend themselves from predators, since natural shelters are pretty rare.

According to the CORINE Land Cover 2006 database, pastures cover the area of 405,316 ha in Bosnia and Herzegovina, or 7.91% of total area of Bosnia and Herzegovina. Compared to the total country area, natural pastures constitute 4,9% or 245,265 ha. Natural grasslands in RS, relative to the total arable land area (1,245,170 ha) take up about 47.50%, of which 78.69% are pastures and 21.31% meadows, which represents a significant natural resource in terms of ecological production in livestock breeding and various medicinal herbs. In addition to the significance of the wide spread of natural grasslands, their richness in phytodiversity, which has a significant impact on quality of forage, is also very important. Phytodiversity researches of the Alpine meadows on Vlačić and Vranica, show great level of phytodiversity, 149 plant species including a large number of endemic ones. The richness of grasslands also appears on karst

plateaus (Kupres, Glamoč, Petrovac). The researches show that it is possible to make quality alterations of natural composition of the grasslands in favor of the quality of forage, as well as to increase the production of biomass depending on the application of agricultural practices (Nedović et al., 2003).

WET HABITATS, PEATLANDS AND MIRES

With regard to characterization and typification, it is necessary at the beginning clarify the meaning of the terms wet (damp) habitats (Engl. *wetland*), peatlands and mires.

According to the *Global Peatland Restoration Manual* (Schumann and Joosten, 2008) a wetland is an area that is inundated or saturated by water at a frequency and for duration sufficient to support a prevalence of vegetation typically adapted for life in saturated soil conditions. In the wet habitats whose water levels are stable (near the surface, just below, at or just above), i.e. under the conditions of permanent saturation by water and absence of oxygen, the dead plant residues do not completely decompose but are slowly accumulated as peat. Peat is accumulation of dead organic material formed on the spot which has not been transported after its formation (which differs from organic sediments). A peatland is an area (with or without vegetation) with a naturally accumulated peat layer at the surface. A peatland in which accumulation of peat is active is called mire. In most mire, this process of peat accumulation lasts for thousands of years so that the area may possibly be covered by a several meters thick layer of peat. The peatlands, where the accumulation of peat is stopped, are no longer considered mires.

When it comes to the reference books used in this part of the world, Resulović et al. (2008) classify the wetlands or wet habitats into three groups: epi-wetlands formed under the influence of superficial, runoff or flooding waters; hypo-wetlands formed under the influence of ground waters; and, amphi-wetlands formed under the influence of superficial and ground water.

In any case, the awareness of interdependence and correlation of the „plant“, „water“ and „peat“ systems is essential to understanding the peatlands. Hydrological conditions determine the type of plant, as well as whether the peat accumulation will occur and how pronounced decomposition of peat will be. Because of the importance of water saturation, formation of peat largely depends on climate and topographic conditions.

Generally speaking, peatland water is essentially important for the botanical composition, just as it is for the formation and conservation of peat. The properties

of mire water, such as acidity (which is related to base saturation) and availability of nutrients (nitrogen and phosphorus, hence there are the oligotrophic mires poor in nutrients, mesotrophic and eutrophic ones) determine which plant species will grow in the mire (biodiversity). These elements focused on the conditions existing in mire, are actually the base for distinguishing the **ecological types of mire**. This is how the most common subdivision of mires was made into ombrogenous mires which are fed only by precipitation (rain, snow...), poor in nutrients and often have acid reaction, and geogenous mires which also receive waters that were previously in contact with mineral soils and bedrock and sustained chemical changes. Similarly, in the **plant ecology** peatlands are divided into minerotrophic, under the influence of underground waters (mires) and ombrotrophic, under the influence of rainfall waters. The marsh peatlands may have a high content of bases (lime mires with high contents of Ca^{2+} as well as Mg^{2+} and K^+), but very low content of nitrogen and phosphorus, and mires with low level of base saturation. (Hajek & Hajekova, 2007).

The mires, i.e. peatlands as such represent free-of-charge ecological services (e.g. water sanitation and flood control, place for depositing carbon in the form of soil organic matter), and biological resources.

The knowledge of aquatic weeds, their ecological and phytogeographical characteristics can serve as a baseline for a successful planning of measures and their control (over-developed aquatic vegetations); taking steps to protect rare, vulnerable and endangered species (preservation of unique genetic resources due to the presence of many representatives of the Tertiary relict flora); and to identify the possibility of biomass utilization (Kovačević and Stojanović, 2008; Nedović et al., 2004).

In Bosnia and Herzegovina there are just a few wetland/peatland sites: Hutovo blato (protected Park of Nature), peatlands of Ždralovac and Jagme in Livanjsko field and Bardača near Srbac, at the confluence of the Vrbas into the Sava River.

The peatlands are habitats for a number of plant and animal, particularly bird species. Under the Ramsar Convention, Livanjsko field is protected as an important habitat for several bird species. It is of a particular conservation interest, being a unique swamp, wetland, low peatland and grassland habitat, typical "Temperate Grassland" according to the UN list of protected areas (Čustović and Bašić, 2008). The peatlands are identified as the most vulnerable and most endangered type of mire habitats which require special attention in terms of conservation and wise management.

The survival of people in rural areas is closely related to their natural resources. This refers primarily to agricultural activities, utilization of hydro potential, exploitation of peat and coal for economic purposes, and agro tourism. However, pressure

on environment is evident. For centuries man has drained wetlands in order to acquire more land for development of agriculture and forestry, as well as commercial exploitation of resources (peat harvesting). In this way, the borders of aquatic and terrestrial ecosystems have changed, the levels of both underground and superficial water have been lowered, and drainage and compaction of soil have taken place as well as a change of peat's physical and chemical properties. Furthermore, as a consequence conditions are created for frequent ignition of peat as well as increased mineralization of organic matter and emission of CO₂ into atmosphere. Human interventions in ecological balance of peatlands also cause changes in biodiversity, microbiological activities, level and quality of waters, land coverage, etc.

Changes in performance of ecological functions of peatland soils are of particular significance. They are manifested through the changes in water-air regime of peat which, mainly as a consequence of accelerated mineralization, produce deterioration of both quality and quantity of organic matter in peat. This changes the climate regulative role of peatlands, i.e. their place within the global carbon cycle, in the sense that instead of being the place for depositing air carbon in peat, they became the place of emitting CO₂ into atmosphere during the process of mineralization.

WATER ECOSYSTEMS

The largest part of the Earth's surface is covered by water (71%), therefore it represents the largest biome. Water is essential to life. Organisms are mostly built of water, while at the same time water represents environment to numerous organisms.

Water is present in various "reservoirs" on the Earth such as oceans, rivers, lakes, underground waters, polar ice caps, atmosphere, and even biosphere. Out of all water on the Earth, 97% is ocean, 2% is polar ice caps and glaciers, while only 1% is fresh water (lakes, rivers and underground waters). The dynamics of water circulation among water reservoirs is called hydrologic cycle (water cycle).

Hydrologic Cycle and Soil Water Balance

The circulation of water through an ecosystem is determined by evaporation which uses sun energy. The speed of water turnover significantly differs from one stated „reservoir“to another. The water turnover period in:

- atmosphere lasts 9 days (average quantity of water in the atmosphere would suffice to cover the Earth's surface with a 2.5 cm thick layer);
- rivers – 12-20 days;

- lake – from several days to several hundreds of years (depending on depth, surface and drainage rate), or 17 years on average;
- oceans – 2,500 to 3,100 years (ocean volume is 1.3 billion km³);
- underground waters – 1,400 years;
- polar ice – 9,700 years;
- swamp – 5 years;
- soil water – 1 year; and
- biological water – a few hours.

From the aspect of providing enough water for the functioning of all land ecosystems, especially agricultural and forestry ones, good knowledge of water regime and water balance of soil is essential. This water and soil relation is important for many reasons:

- Large quantities of water need to be supplied to the plants in order to meet their requirements during the growth, where a part of water is continuously lost due to transpiration. This water has to be accessible when the plants most need it, while its most part has to come from soil.
- Water is a solvent which in combination with nutrients makes a solution from which plants absorb the essential elements for their nutrition.
- The soil water establishes control over the other two factors important for a regular growth of plants – air and temperature of soil.
- Control of water disposition, especially at the moment of its impact on soil, allows the control of incident soil erosion which threatens to remove the soil particles from the surface and take them into the watercourses, lakes and seas.

The soil has the water income and outcome, while the soil water regime outlines the way soil manages the water: how it receives water, how it circulates within and makes itself available to the plants' root, or, how it loses water. However, from the agroecological point of view, it is very important to know the difference between the quantities of received and lost water. This difference between the sum of water incomes (receipts) and losses is called **water balance**.

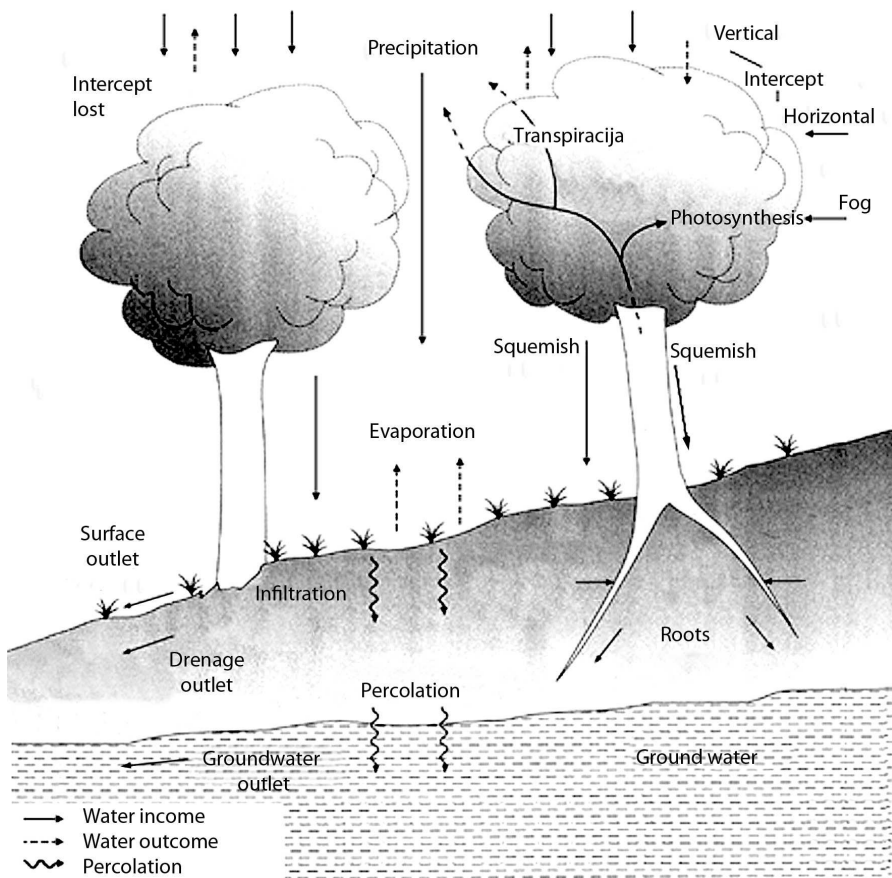
The following may be identified as the water income in soil during the monitoring period: reserves of water in soil at the beginning of the studied period (V₀), precipitation (O), condensation of water (K) and underground affluence (Pd); while expenditures are identified as: evaporation (E), transpiration (T), runoff (Op), gravitational runoff (G) and lateral runoff (Bo). Accordingly, the water in soil is in a continuous process of circling, i.e. hydrologic cycle, as it is shown in the chart. The quantity of water that remains at the end of the studied period (V₁) is calculated using the following equation:

$$V1 = V0 + (O+K+Pd) - (E+T+Op+G+Bo)$$

(income) (loss)

Therefore, the soil water is in a constant natural cycling process or hydrological cycle. Forests play an important role in water circulation. A part of water is retained in the forest canopies, and this process is called interception. The presence of the forest litter influences the regulation of both infiltration (absorption) and filtration (percolation) of the rainfall. The presence of organic matter, as well as plant vegetation on the soil surface in general, considerably reduces or even eliminates runoff and erosion.

The presence of snow in the tree tops and trees can reduce the content of moisture in soil up to 50 %, relative to the surrounding bare areas. Generally, the evaporation processes (evaporation from the bare soil surface) from the forest land is by one half smaller than from the agricultural land, but the losses due to transpiration under the forest vegetation are considerably higher than in case of agricultural land.



Picture 2: Hydrologic cycle in forest basin

SEAS

Oceans and seas cover more than two thirds of the Earth's surface. Life was first born in the oceans which today make physical environment to a number of various species, from microscopic organisms to the world's largest animal – blue whale. Oceans are the engines or fuel for climate processes as their currents transport the accumulated sun energy across the planet.

It has already been stated that life in aquatic biomes is determined by variations of two groups of ecological factors:

- physical (light, temperature, movement of water masses), and
- chemical factors (salinity, oxygen).

The enormous quantity of water is distinctive by its properties, primarily temperature, salinity, pressure and level of light.

In sub-tropical and tropical seas, sunlight heats the upper layer of water creating thus a broad water area whose temperature is 25 °C. At depth of 300-1000 m temperature drops to around 8 °C (thermocline layer), while at bigger depths ocean temperature is around 2 °C. Water has a huge thermal capacity. It is also resistant to the change of state.

The sea water density is 800 times bigger than the air. The maximum density is recorded at the temperature of 4 °C. The pressure increases with depth (1 bar by each 10 m) so that deep sea animals have to be adjusted to such conditions.

About 80% of sunlight energy is absorbed in the first 10 m. Different light wave lengths penetrate to different depths. The infrared light is absorbed already in the first meter, while the blue light penetrates much deeper. Photosynthesis is limited to the upper sea layer up to 200 m of depth.

Water as a universal solvent has a large capacity of dissolving inorganic and organic compounds. The average salinity of seawater is around 35 g/l or 35‰. Out of cations present in seawater, the principal ones are Na⁺ and Mg²⁺, and Cl⁻ and SO₄²⁻ of anions. Dissolved salts lower the freezing point to -1.9 °C at salinity of 35‰. Sea water has high osmotic potential. It contains dissolved gases (O₂; CO₂) as well.

Concentrations of minerals in seawater are often limited by their maximum solubility. Mineral calcite (CaCO₃ – calcium carbonate) dissolves only up to the concentration of 0.000014 g/g of water. This level of ion concentration is reached earlier, so that surplus calcium ions are deposited thus forming calcareous rocks. Mineral halite/salt (NaCl – sodium chloride) is another extreme, as its solubility in water is very high and amounts to some 0.36 g/g of water, which is considerably above its current concentration in seawater.

RIVERS

Rivers are very dynamic systems. Heraclitus wrote: *Panta rhei – everything flows, everything changes*; “No man steps into same river twice”. It can be stated that rivers are the extensive drainage systems on land. By accumulating water (surface and ground) and increasing their width and flow intensity, they carve river beds and valleys. Some of them made and widened cracks in the Earth’s crust so that they can flow under the ground creating thus an entire system of caves (characteristic for karstic areas).

A river and its tributaries make up the catchment – the area from which all surface and ground water is collected. A boundary which separates the river catchments is called watershed. A diversity of river systems depends on the characteristics of relief (primarily inclination) conditioned by the movements of Earth’s crust, geologic substrate (rocks), as well as precipitation levels. Tributaries feeding the main river generally have the shape of tree limbs.

Flow and chemical properties of rivers change in accordance with climate regimes. They are found in almost any land regions except in the coldest, driest and warmest ones. Though representing only a small percentage of the total water on the Earth (one fortieth part of a percent) they still play an important role in relief shaping. Namely, rivers have the biggest erosion power on land, so that river valleys and hilly terrains make the most distinct landscapes. Rivers transport and disintegrate previously eroded material but also wear down and transport the surrounding rocks. By gravitational flow they annually transport around 20 billion tons of eroded material all the way to the sea. The size and shape of eroded material depends on the speed and intensity of the rivers.

In the river deposits it is possible to find rocks, gravel and sand that are transported by rolling over the riverbed; however, most material is transferred by suspension, i.e. suspense of fine particles of clay, dust and grit. The accumulation of sediments begins when the river speed and transportation intensity are weakened. This normally happens when riverbed broadens due to flat terrain, at bends. This is how specific relief shapes are formed such as sand banks, natural embankments, shoals and aits (small islands in a river), as well as some larger forms such as fluvial lowlands or river deltas (the mouth of a river where it flows into the sea) characteristic for the lower part of the river flow.

Dams and water accumulations - another characteristic of rivers are **dams**, the biggest structures on the Earth. These are artificial barriers built on rivers for the purpose of accumulating water whose power is then used to produce electrical

energy. This is a renewable source of energy, theoretically harmless for environment. Dams also have the regulatory role in reducing the flood and drought risks.

Since accumulations are mainly built in rural areas it could be stated that the construction of small dams and accumulations is of vital importance for life in rural areas in many places around the world. They serve as a source of water to supply settlements and agriculture too. Additionally, they are suitable for tourism and activities such as sports, recreation, fishing and catering, which considerably diversify the rural offer.

However, on the other side of the river dam, transportation of river deposits (fertile substrate) is stopped and its sedimentation in downstream alluvial flatland is prevented. Though the accumulations make new habitats for animals and plants (due to turbidity they become suitable for floating plants), they are still a physical barrier to fauna living in and around water, particularly fish that frequently migrate.

Due to the construction of 4 hydro-power plants on the Neretva river, which was well known for some fish species such as huchen (even a nearby settlement was named after it) and softmouth trout (Adriatic trout), some areas of the river remained without these species since dams were insurmountable barriers to the migration of these species.

Distribution of organisms in rivers is determined by their flow velocity, distance from the source and nature of river deposit. Rivers are characterized by a three-dimensional structure:

- Longitudinal structure – implies the subdivision of river stream into upper, middle and lower reaches. The upper reach is characterized by bigger inclination and inflow of smaller tributaries, colder water, higher concentrations of oxygen, lower density of phytoplankton, and lower concentration of nutrients. So-called cold-water fish species (e.g. trout) are typical. The lower reach of river stream is characterized by smaller inclination and slower flow, bigger concentration of nutrients and phytoplankton, higher temperature and less oxygen. So-called warm-water fish species (e.g. carp) are typical.
- Lateral structure – implies the subdivision into central (deepest) stream (mainstream); banks zone; and, fluvial zone (part of bank which is under water only in case of high water levels)
- Vertical structure– includes the surface layer (epilimnion), middle layer (metalimnion) and bottom layer (hypolimnion).

LAKES

In contrast to rivers, the lakes are like little seas. The size of lakes varies from that of an average pond to those whose depth goes up to one kilometer. Major part of fresh water in biosphere is contained in several lakes (Great Lakes – 20%; Lake Baikal (1600 m) – 20%). Some lakes are a few million years old while most of them are geologically much younger as they were formed after the last ice age.

Lakes were formed as a result of tectonic forces, volcanic and glacial activities. Usually these are waters accumulated in relief depressions (tectonic faults, blockage of riverbed by volcanic lava, or as in case of the Caspian Lake, separation of a major part of seawater) with no direct outlet. Most lakes are the result of glacial activities – retreat of glaciers in glacial erosion forms or by blocking the water streams by moraine material deposited by glaciers.

Lakes are normally fed by surface rivers and streams which may bring a considerable quantity of sediment. From the geologic point of view, lakes have a short life span because of gradual rise of deposited materials and lowering of water level through rills.

The structure of lake environments is similar to those of seas, just on a much smaller spatial scale. The salinity of lakes varies from almost completely fresh to salty whose salinity reaches up to 200‰ (typical for arid areas).

Based on nutrient content lakes are divided into oligotrophic (poor) and eutrophic (rich in nutrients). Temperature stratification and vertical mixing of water depend on geodetic latitude.

Vertical structure of lake:

- Epilimnion (E) – top zone of free water which matches littoral and sub-littoral zone of lake. This zone is distinguished based on temperature. This is the layer the most heated during the summer.
- Metalimnion (M) – a border layer between epilimnion and hypolimnion where abrupt change of temperature occurs (thermocline)
- Hypolimnion (H) – bottom zone of free water in a lake (normally below 30 m depth) characterized by lower temperature, absence of light and reduced concentration of oxygen
- Littoral zone – a slope area close to land, expanding 20-50 m in depth

- Limnetic zone – the upper of the two zones distinguished in the vertical profile of a lake. It includes water in which the light penetrates and extends from the surface to the depth of 20 m, sometimes even up to 50 m. This zone stands out based on penetration of light and does not necessarily have to coincide with epilimnion.
- Profundal (benthic) zone – the lower zone which continues after the limnetic zone and goes all the way to the lake floor. This zone is characterized by lower temperatures and absence of sunlight and it largely coincides with the hypolimnion.

GROUNDWATER

Groundwater is actually a reservoir of water that lies beneath the ground surface on impermeable bedrock. The space filled by groundwater is in fact pores existing within sediments, mainly sand and gravel. Most part of groundwater comes from atmospheric precipitation, river streams and condensation of vapor in the superficial ground layer. Level of groundwater over the year may vary depending on ratio between water recharge and discharge, i.e. quantity of precipitation and inflow velocity. If it is located at smaller depth, it can impact development and properties of soil.

Groundwater is usually used as a source of drinking water since, due to its favorable microbiological, physical and chemical properties compared to other water reservoirs, it requires less investments in purification technologies. It is also often used in agriculture for irrigation. If the groundwater has capillary capacity, it becomes an excellent way of supplying the plants with water in the dry part of the year. Groundwater may also be harmful for plants in case it contains soluble salts in substantial quantities, as well as poor in the oxygen due to reduction processes.

An interesting freatic or interstitial fauna (tiny fibrous organisms inhabiting space between sand grains, interstitial sliders and grubbers, often blind) is living in groundwater which penetrates the sediment to a certain depth, in the space between the sediment particles (sand or gravel). This area has two distinctive zones:

- Hyporheic – upper shallow layer of gravel or sand under the influence of land climate and

- Freatic – deeper layers of sand that show the characteristics of true underground (very small temperature oscillations and very small influence of land climate).

SELF-PURIFICATION OF FRESH WATER

Human settlements have historically been built in the vicinity of water. It provides drinking water and food source (aquatic animals), but also serves as a waste disposal site. What we first notice about this statement is that these two ways of using water exclude one another. Lack of good management can cause pollution of water which increases the risk from diseases. Developed countries have stepped up the water protection measures while in poor countries poor quality of water still remains a major health issue.

Drinking water can rarely be found in nature. Groundwater is generally purer than surface water as it purifies itself by passing through soil and porous rocks that serve as filters. It contains dissolved minerals and very little organic matter.

The surface water also contains dissolved minerals as well as numerous organisms and their remains. Most abundant organisms are bacteria that require oxygen for decomposing organic matter in water and purify it. This is why the process of self-purification or auto-purification of water is most represented in waters rich in dissolved oxygen.

The process of water self-purification is influenced by the process of water exchange. If water is oversaturated with organic remains, e.g. waste materials, the process of self-purification can fail.

Bosnia and Herzegovina falls under the areas rich in water, especially its central part. This is even more significant if we know that most of Bosnia and Herzegovina water originates there. Water resources of Bosnia and Herzegovina include primarily the capacities of rivers, lakes and sources of groundwater. The groundwater capacities still represent a significant source for supplying the settlements with fresh water, especially in the northern parts of the country, however, further increase of their utilization is limited and cannot respond to the ever growing water supply demands since groundwater, just like the surface ones, are not free from contamination processes.

BIOTIC FACTORS

Living organisms (disease pathogens, weeds, soil organisms, wild and domestic animals) and their mutual relationships represent biotic factors of environment. Their impact is examined through various interactions among organisms:

- Competition – competitive fight over resources (food, space, sexual partner etc.), representing a relationship detrimental to both organisms
- Predation – interaction between predator and its prey, which is beneficial to predator and detrimental to prey. Organisms that are extremely smaller than their predators show very little adaptation in order to avoid them. On the other hand, larger prey can hide, run away or fight. Plants use structural and chemical defensive mechanisms against herbivores. Plants cannot run away so they have to rely on metamorphosed organs (thorns), epidermal growths (glandular and burn hairs) and secretion of various poisonous compounds, to protect themselves.
- Parasitism - a symbiotic relationship in which the parasite benefits at the expense of its host. Unlike predators who kill their prey instantly, parasites never kill their host or at least never instantly. Parasites are normally much smaller than their hosts. They live either on the host's surface (ectoparasites), or inside its body (endoparasites). Unlike the useful microorganisms, parasites can cause serious decrease of yields in agricultural production. They are present in the soil in large numbers, but luckily are in antagonistic relationship with many useful microorganisms that provide preemptive protection from infections, e.g. *Mycorrhizae*. The plant parasites such as nematodes are in association with many plants. Endoparasites live and feed inside the plant tissue, whereas ectoparasites feed on the plant wall creating thus locations suitable for development of disease. Nematodes that feed on plant roots belong to the class of true parasites.
- Commensalism – unilateral relationship, beneficial for one organism and neutral for the other (orchids which in natural environment grow on trees but have no impact on them).
- Ammensalism – unilateral relationship, detrimental for one organism and neutral for the other (a taller tree overshadows a smaller one).
- Mutualism – mutually beneficial relationship: ***Mycorrhizae*** is a type of fungi which forms a mass of mycelia or thread-like hyphae on the roots and increases the marginal root area. They grow on younger and finer roots that are more active in nutrient uptake. Root systems of many plants are infected by these fungi. Mycorrhizal activity in association with plant root improves

plant's growth by transforming nutrients from inaccessible to accessible forms for the plant. Additionally, they are useful as they protect root from some pathogens (secretion of antibiotics); they induce better tolerance to diseases and reduce tolerance to soil toxicity and high temperatures. Like other fungi, it also improves the soil structure, by binding the tiny particles of clay with its hyphae. This way it facilitates aeration of rhizosphere layer creating thus conditions suitable for beneficial aerobic bacteria capable of nitrogen fixation, increasing solubility of phosphorus and other minerals making them more accessible for the plants. Additionally, their hyphae bind sand grains thus increasing the water retention capacity which is useful to both the plant and bacteria.

Influence of humans as a biotic factor is particularly significant. Man has become a global power that populates 80% of the total land area on Earth, and as an environmental factor he has influenced environment since ancient times. Humans taking from nature and adapting the environment they live in to fit their desires and requirements can be defined in two ways, both positively and negatively.

ADAPTATION OF ORGANISMS

Although different from their physical environment (they have the ability of moving and reproducing), organisms yet do not function separately, but within a complex system of interdependence. The survival of organisms often depends on their ability to adjust to the conditions in outer environment. This ability represents a characteristic of organisms and depends on its intrinsic genetic properties, which can be considered as an internal ecological factor.

Adaptation of organisms to the external physical environment is actually structural and functional modifications of the organism directed toward its better harmonization with environment. Adaptations can develop as:

- Evolutionary adaptations (hereditary characteristics of the species, which are the result of natural selection occurring over a long series of generations), and
- Individual adaptations – response of an individual organism through behavior, physiology or development.

The adaptation of living organisms to the conditions of physical environment can be considered through their adaptation to different conditions pertaining to water availability, temperature differences and presence of oxygen. Speaking about

water accessibility, it is a well-known fact that **water** is essential to living organisms and that all organisms, no matter where they live, are largely consisting of water (50-80%). To what extent will water be available to organisms depends on movement of water along the concentration gradients in both land and aquatic environments. In aquatic environments water moves faster along the concentration gradient from the solutions with lower concentration of salts toward the solutions with a higher concentration of salts. This movement of water creates osmotic pressure. The bigger the osmotic difference between the organism and environment, the bigger the osmotic pressure. In land ecosystems, plant life is supplied with water mainly from soil. Within the soil, water moves from the area of bigger water potential to the area of a smaller one. Water potential of pure water is zero, and it goes down with the addition of salt, therefore water potentials in nature usually have negative values. Water potential in soil is also reduced by adhesion forces keeping water and soil particles together (the smaller the particles, the higher the force that holds water). Water in soil available to plants (accessible water) is between the point of definite fading and the capacity of soil to retain water or field water capacity (humidity kept by soil's attractive forces).

Land plants and animals regulate their internal concentration of water through balanced intake and loss of water. Retention of water becomes difficult to land organisms when temperature goes up. Both plants and animals develop numerous adaptations to preserve water. When a plant opens its stomas to take CO₂, at the same time it loses water. This problem becomes particularly pronounced in hot and arid areas. In order to preserve water some plants have modified the carbon assimilation mechanisms.

Land animals receive minerals through feed and water, while plants absorb ions dissolved in water and soil. Animals, especially the carnivores, with their food receive a surplus of salt. They drink a lot of water and excrete salt. In places where water is scarce animals produce concentrated urine.

Organisms are adapted to temperature of the environment they live in. Microclimate in its interaction with local landscape (altitude, exposure, vegetation, land color, structural forms such as rocks or holes) creates microclimate. Microclimate may be more relevant than macroclimate for an individual organism. Most species show maximum of their activities within a very narrow temperature range, a range which just fits the temperatures in their biotope. The impact of temperature on organisms' activity begins already at molecular level, where temperature impacts the enzyme activity. As every organism changes during its development, the effect of temperature on development rate is different for different developmental stages. There are several important temperature parameters:

- Development threshold temperature – the lowest temperature at which development stops
- Temperature constant – expresses a total sum of thermal energy required for a certain development stage or overall development of an individual, regardless of the temperature at which development occurs (principle of “heat sum” or “sum of effective temperatures”).

Regulation of body temperature takes place through establishment of balance between received and lost heat. Organisms can achieve it through morphological adaptations, behavior or metabolic activity. Plants usually regulate their temperature through transpiration.

Ectothermic or cold-blooded organisms do not regulate their body temperature through metabolic activities, so it depends on the temperature of the environment. Through morphologic and anatomic adaptations, as well as behavior, these organisms employ various mechanisms for exchange of heat between themselves and environment (radiation, conduction, convection and evaporation). Such organisms include all plants and all animals except for mammals and birds.

Endothermic or warm-blooded organisms actively regulate their body temperature through metabolic activities. Such organisms include mammals and birds. Many organisms survive extreme temperatures in the ways which involve or hibernation/aestivation and reduced metabolism.

Speaking of availability of oxygen in the environment, it is necessary to point out that most energy transformations in biological systems are based on carbon and oxygen chemistry. The availability of oxygen in the environment can limit metabolic activity. This particularly refers to the aquatic environments because of low solubility and diffusion of oxygen.

Adaptations of organisms aimed at improved oxygen supply depend on concentration of oxygen in environment as well as their oxygen requirements. A major factor in regulating oxygen requirement within a physical environment is the capacity of organism’s hemoglobin to bind oxygen. Other important adaptations include size of lungs, tidal volume and inspiration rate, size of heart, blood circulation rate and volume, capillary density.

The survival of any individual depends on their capability to resist to changes in the environment. Homeostasis is the ability of an individual to maintain constant internal stability, despite variable conditions in its environment. There are different types of **responses of organisms to the changing environment conditions**:

- Regulation responses – include changes in the speed of physiological processes e.g. metabolism, as well as changes in behavior (e.g. seeking of shade) *Artemia salina* (shrimp inhabiting salt pans) maintains concentration of salt in its body below 3% even in a solution with salt concentration of 30%.
- Acclimatization (adaptation) responses – these responses include morphological, e.g. growing of winter fur and biochemical modifications e.g. increase of red blood cell count at higher elevations.
- Developmental responses – occur when changes in the environment are slow so that individual organisms can alter their development in order to produce the most appropriate form. Young pine tree seedlings growing in shade have smaller root system, more leaves and higher rate of photosynthesis compared to those growing in sunlight (due to higher humidity in shade). Ecotypes represent genetically differentiated strains within a population which are adapted to a limited specific habitat.

In case that none of the above stated types of response to environment changes can overcome adverse conditions, organisms resort to the extreme responses such as:

- Migrations – main reasons for migration include: food and adverse conditions for reproduction,
- Storage of food (energy) – cactuses store water during the rainy period. Numerous plants store nutrients. Animals (especially the Arctic ones) accumulate fat as energy reserves during the period with abundance of food. Animals active in wintertime store food under the tree bark or bury it (e.g. beaver, squirrel, woodpecker, jay).
- Physiological dormancy– numerous tropical and sub-tropical trees lose their leaves during dry periods; trees of temperate and arctic zones shed their leaves in autumn since they cannot take water from the frozen ground; plant seeds, as well as spores of bacteria and fungi tolerate long periods of dormancy; many mammals hibernate due to lack of food (“winter sleep”); for this period of inactivity, organisms prepare through a series of physiological changes (production of “antifreeze”, dehydration, fat storage); insects during extreme heat or cold enter a „sleep time“ – diapause.

ECOSYSTEM ECOLOGY

Ecosystem ecology studies the exchange of matter and energy between the organisms and their environment. There are different approaches to examining and understanding these complex relations within an ecosystem. Elton (1927), an English zoologist and ecologist, regards ecosystem through food relationships. His book *Animal Ecology* marks the beginning of modern ecology. Lotka (1925, 1939), an American mathematician and biophysicist, advocates the thermodynamic view of ecosystem. He studied communities treating them as thermodynamic systems that are possible to describe with a set of equations pertaining to the interactions between the system components. Lotka viewed ecosystem as a part of the world machine responsible for the transformation of sun energy coming to the Earth's surface (Lotka's *Millstone of Life*). Lindeman (1942) published a paper outlining the concept of ecosystem as a system for transformation of energy. He accepted the Elton's concept of food-chain comprising several grades (producers, consumers) and called them trophic levels. Lindeman introduces a "pyramid of energy transformations", in which less energy becomes available to the higher trophic levels.

After having the concept of ecosystem clearly established, ecologists started to measure the throughput of energy and circulation of matter in ecosystems. The most renowned representative of such research approach is the American ecologist Odum (1953) of the Georgia University, whose book *Fundamentals of Ecology* (1953) has influenced generations of ecologists. Odum suggests presentation of ecosystems with simple diagrams of energy flow, where the circling of elements was given a special attention as their movement between different components could be a good indicator of energy throughput which could hardly be directly measured.

TROPHIC (FOOD) LEVELS IN ECOSYSTEM

Several fundamental processes take place within an ecosystem: assimilation, photosynthesis, consummation, decomposition, transformation (conversion). In this context, any ecosystem has the following trophic (food) levels:

- Producers
- Consumers (herbivores; carnivores; omnivores)
- Reducers (detritivores - decomposers)
- Transformers

Based on the trophic status of an organism the following distinction is made:

- Autotrophic organisms – produce organic matter using inorganic source of carbon (CO_2)
- Photoautotrophs – use the energy from sunlight to synthesize organic matter
- Chemoautotrophs – produce energy through the process of inorganic substrate oxidation
- Heterotrophic organisms – use already made organic matter (organic source of carbon); acquire energy from oxidation of organic compounds
- Osmotrophs – use organic matter in dissolved form (bacteria)
- Phagotrophs – use organic matter in particulate form (all animals)
- Mixotrophs – organisms which perform photosynthesis, but depending on environment conditions may switch to heterotrophic way of nutrition (numerous protists).

FLOW OF ENERGY IN ECOSYSTEM

When it comes to the productivity of an ecosystem, distinction is made between primary and secondary production. Primary production occurs at the level of producers (autotrophic production) through the process of photosynthesis. Secondary production refers to the consumer level (heterotrophic production).

Photosynthesis is a process used by plants to receive energy of the sunlight and transform it into the energy of chemical bonds in carbohydrates. Simply said, it is a process in which plants use CO_2 , water and nutrients solved in it to produce organic matter and O_2 in their green parts with the assistance of the sunlight energy.

The photosynthesis rate depends on a series of ecological factors such as: light, temperature, CO_2 , water and mineral salts. Production limiting factors are different in land and aquatic biomes. Primary production on land is generally limited by temperature and humidity, whereas aquatic habitats are limited by nutrients.

Temperature and humidity of land ecosystems is integrated into a single indicator called actual evapotranspiration (AET). AET is the total quantity of water evaporated and transpired from a specific area during the year. Annual AET is generally positively correlated with photosynthesis in land habitats. Namely, land plants use their stomas on green leaves to exchange gases (CO_2 uptake and O_2 sequestration),

and at the same time perform transpiration whose effect is loss of water. Under the water shortage conditions, plants close their stomata preventing CO_2 to enter the leaf so that the process of photosynthesis is slowed down or completely stopped. Therefore, photosynthesis rate depends on the plant's tolerance to the water loss, availability of soil water, as well as the impact of temperature and sunlight on transpiration rate. The effectiveness of transpiration is the ratio of net primary production and transpiration (indicator of drought resistance in plants). In most plants, it is less than 2 grams per 1 kg of water while it amounts to approximately 4 g per 1 kg of transpired water in those resistant to drought.

In addition to the temperature and humidity limitations, primary production in land habitats depends locally on the quantity of nutrients in soil too. Lack of nutrients in soil hence reduces primary production in many habitats. Anyway, the highest rates of primary production on land are achieved in warm and humid habitats.

As for the primary production in aquatic ecosystems, it takes place at relatively thin superficial layer in sea which receives enough light (since they). Primary production in aquatic habitats in general is determined by the availability of mineral salts - nutrients. Numerous researches confirm a positive ratio between the quantity of nutritive salts and primary production in aquatic habitats. Primary production is limited the most commonly by level of phosphorus in the fresh water ecosystems, and lack of nitrogen in the sea ecosystems.

Secondary production in an ecosystem pertains to the production by consumers. Heterotrophic organisms use organic molecules as a source of both energy and carbon, and are fully dependent on carbon and energy fixated by autotrophs. Heterotrophs include three major groups of organisms:

- **Herbivores** – organisms that feed on plants,
- **Carnivores** – organisms that feed on animals,
- **Detritivores** – organisms that feed on organic waste (mainly plant residues) and
- **Omnivores.**

CYCLING OF ELEMENTS

Elements cycle between organisms and their abiotic environment in an ecosystem, while undergoing chemical transformations. Live systems transform elements and their compounds in order to get nutrients and energy. There is a harmo-

nious balance in which matter continuously cycles in the communities of plants, animals and microorganisms. Within this cycle, a green plant through the process of photosynthesis takes the energy of the sunlight and produces organic matter. This matter, after the plants as well as animals have died, gets decomposed through the process of mineralization which releases energy. Released mineral matters serve again as nutrients for the plants and a new cycle of photosynthesis. This process is continuously repeated in nature.

From the long-term perspective, these processes that transform elements from one form into another have to be well balanced with the processes that revert them into the original form. However, the cycles of elements may sometimes become unbalanced so that elements accumulate or get removed from the system. Such an example is the formation of fossil fuels and peat under anaerobic conditions where occurs a delayed and incomplete process of decomposition and accumulation of organic matter. According to the Millennium Assessment, since 1960, flows of reactive (biologically available) nitrogen in land ecosystems have doubled, while those of phosphorus have tripled. This is brought into connection with application of mineral fertilizers.

Since the natural ecosystem is a dynamic system that continuously changes (natural and anthropogenic changes), in case that its cyclic processes are disturbed or disconnected (cycling of matter and energy), it will face extinction.

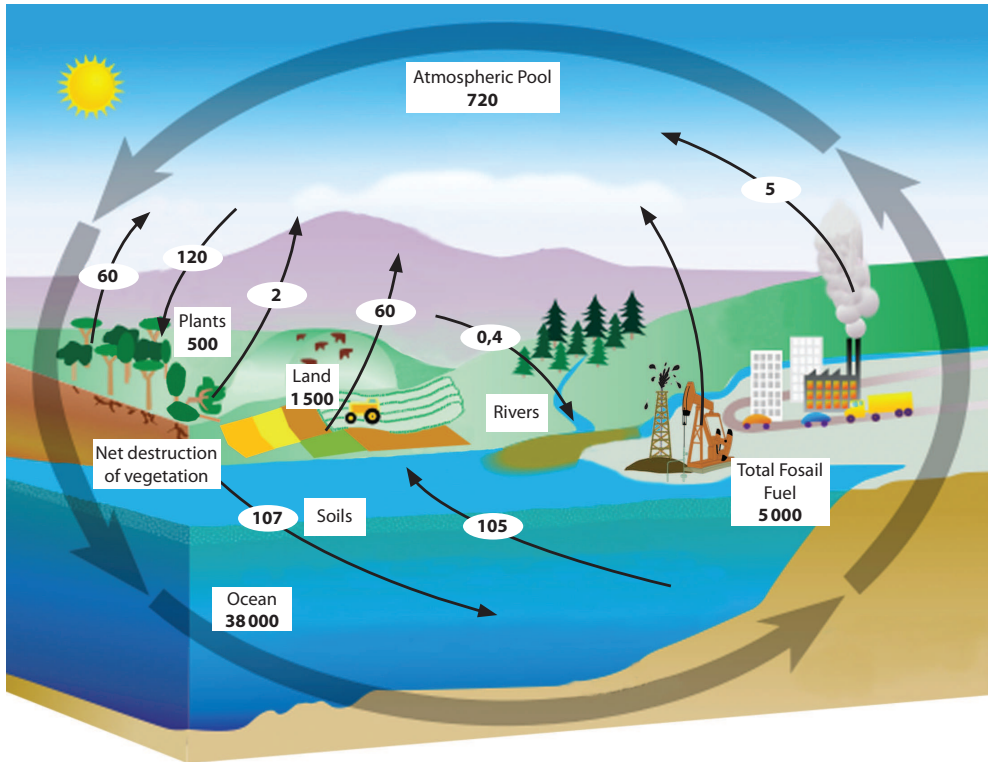
Carbon Cycle

Though there are no big quantities of carbon in nature (only around 0,1 %), it belongs to the group of essential biogenic elements as it is a constituent part of the overall organic world, i.e. plants, animals and microorganisms.

It is found either as free or locked up in nature. Free carbon is found in the form of diamonds and graphite, while as locked up is found in its organic and inorganic compounds. Most common inorganic compounds are carbonate rocks as lime and dolomite (CaCO_3 and $\text{CaCO}_3 \cdot \text{MgCO}_3$) and oxides (the most prominent oxide of carbon is carbon dioxide - CO_2).

The organic form of carbon is found in a number of various compounds. Most of them are carbohydrates produced in the process of photosynthesis by plants and phototrophic and hemotrophic microorganisms. These are monosaccharides (pentose and hexose) and polysaccharides (cellulose, hemicellulose, starch and pectin). Most energy transformations in biological systems are based on carbon and oxygen chemistry. In case that transformations of carbon occur as a part of metabolic processes of living organisms, such cycling is called small, and if transformations occur outside biosphere it is called large carbon cycling.

According to the Intergovernmental Panel on Climate Change (IPCC, 2001), major components of the carbon cycle in nature are oceans with 38.000 Gt C, atmosphere with 730 Gt C, and carbon stored in terrestrial ecosystems: 1.500 Gt C in soil as organic matter, and 500 Gt C in plants. Movement of carbon molecules from one form to another is known as carbon cycle.



Picture 3: Biochemical cycle of carbon in Gt (gigatons) (Schlesinger, 1991)

As it is shown in the picture above, the annual exchange of carbon between land ecosystems and atmosphere amounts to 120 Gt C year⁻¹. The process of the soil organic matter mineralization releases 60 Gt C, plus 60 Gt from respiration, while plants, in the process of photosynthesis, sequester 120 Gt C in the form of CO₂.

CO₂ easily dissolves in water so that the oceans have around 50 times bigger concentration of CO₂ than atmosphere. The rate of CO₂ outflow at the border between air and water is controlled by physical and biological processes. Winds above the ocean surface create a situation where partial pressure of CO₂ in the air is in balance with the pressure immediately beneath the surface. Since primary production consumes CO₂ and reduces its concentration in the top layer of water, this enables for CO₂ from air to be transported to the ocean's interior (phenomenon known as biological pump). High geodetic latitudes are characterized by cold water (solubility

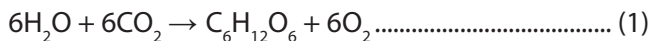
of CO₂ is two times higher at 0 °C than at 20 °C), as well as downwelling of cold and thick water which rapidly removes CO₂ from the top layers.

Disturbance of any of these forms of stored carbon, such as oceans, atmosphere or terrestrial ecosystems, has direct impact on the other ones due to interconnectivity and interdependence of individual carbon sources.

The role of soil in carbon cycle –Soil contains the largest „active“ terrestrial form of carbon on the Earth as soil organic matter (versus „passive“ geological carbon reservoir in carbonate rocks), twice as much as the atmosphere and nearly three times more than the vegetation cover. It is estimated that the soil through respiration (releases CO₂ as a product of the mineralization of organic matter and respiration of root and soil microorganisms, and penetration of O₂ from the atmosphere into soil) participates in the annual outflow of CO₂ into the atmosphere (60 GtC year⁻¹) with an emission that is 10 bigger than the one caused by combustion of fossil fuels (Schlesinger, 1997).

The carbon cycle is most closely related to energy flow in an ecosystem. The fundamental function of the soil organic matter is to supply energy required for biological processes. Carbon fixed in the process of photosynthesis gets on and into the soil through biomass residues becoming thus available to the soil micro and macro organisms. Biological decomposition occurs due to detritivores' requirement for carbon as energy source, however, it results in release of N and S bonded with C.

Most important reaction (formula 1) that enables life on Earth is fission of water molecules using the sunlight energy, performed by green plants and algae in the process of photosynthesis.



The opposite reaction – formation of water in respiratory chain – is the most important reaction for producing energy in aerobic organisms, i.e. practically in all animals.



Respiration of plant roots and microorganisms in soil also releases CO₂ from soil.

NITROGEN CYCLE

When a Nobel Award Winner, Professor Paul Crutzen (1970) demonstrated how NO and NO₂, originating from N₂O produced by microbiological decomposition of the soil organic matter, react catalytically with ozone, thus accelerating the rate of its reduction, this information received a lot of public attention. His explanation of the connection between microorganisms in the soil and the thickness of the ozone layer is one of the motives for the recent rapid development of research on global biogeochemical cycles.

Nitrogen falls under a group of elements that are essential to life of microorganisms, plants and animals. It is a building block in all amino acids, proteins and nucleic acids and through them it becomes a constituent part of all living organisms. Nitrogen is present in atmosphere, soil and water.

The atmosphere contains large quantities of nitrogen. It constitutes around 78% by volume, i.e. around 75% by weight of Earth's atmosphere. More than 90 % of atmospheric nitrogen is in the elemental form of N₂ while the remainder is in the form of nitrogen-suboxide (N₂O), nitrogen-monoxide (NO), ammonia (NH₃), nitric (HNO₃) and nitrous (HNO₂) acid. Water contains very little nitrogen and most of it is in organic form.

The following sources of nitrogen exist in soils with significant content of clay, minerals of the illite type, which are capable of fixating NH₄⁺ ion:

- about 90 % N in soil is contained in the soil organic matter,
- 8 % N in the form of NH₄⁺ ion fixed by clay minerals and
- 1-3% N in inorganic form accessible to plants (NO₃⁻, NH₄⁺)

Gaseous forms of nitrogen (N₂, NO, N₂O, NH₃) move from soil into the atmosphere. Most part of inorganic nitrogen in soil is formed by mineralization of organic compounds during the metabolic processes in microorganisms, while its smaller part originates from bedrock, precipitation and mineral fertilizers.

The nitrogen cycle comprises several stages that are mainly microbiologically performed. Each stage of the nitrogen cycle is equally important. They occur simultaneously and provide a continued presence of both organic and inorganic forms of nitrogen in soil, air and water.

In terms of quantity, the most significant flow of nitrogen follows this cycle:

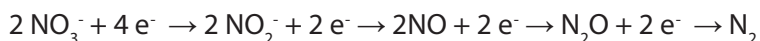
nitrate → organic N → ammonia → nitrite → nitrate

The plants uptake nitrogen from soil in the nitrate NO_3^- (from soil solution) and nitrite NH_4^+ (from soil solution and absorbed on negative soil colloids) forms. These accessible forms of nitrogen get into the soil mainly through the process of mineralization of the soil organic matter, as well as through electrical discharge and free fixation from the air, and fertilization.

Mineralization of organic N in soil is a microbiological process in which organic forms of N from the soil organic matter (proteins, hexosamines, purine and pyrimidine) are converted into inorganic forms (ammonia, nitrites and nitrates). The mineralization process comprises 3 phases:

1. *Aminization* – heterotrophic bacteria, fungi and actinomycetes decompose the complex of organic molecules with nitrogen to amines and amino acids.
2. *Ammonification* – process in which organic forms of N by hydrolysis of amino groups are transformed into ammonia (NH_3) or ammonium ion NH_4^+ . This process is performed by various heterotrophic microorganisms (bacteria, fungi, actinomycetes) under aerobic and anaerobic conditions. The resultant ammonia may be: lost by evaporation, taken up by plants, absorbed onto the soil adsorption complex, fixed by stratified minerals (clay minerals) in inner layers, immobilized by microorganisms or nitrified. In acid soils ammonification has ecological significance as ammonium ion is adsorbed to soil particles, which prevents its oxidation to nitrates and possibility of leaching.
3. *Nitrification* – microorganisms oxidize ammonia to nitrates in neutral soils with plenty of free oxygen, thus obtaining energy necessary for the cell functioning. Nitrification has two phases. In the first phase, ammonia is converted to nitrites (NO_2^-), by autotrophic bacteria *Nitrosomonas*. In the second phase, autotrophic bacteria *Nitrobacter* convert nitrites into nitrate ion (NO_3^-). Such resultant nitrate ion may be: taken up by plants; leached from soil which is a detrimental process as it increases concentration of nitrates in ground waters; under anaerobic conditions it may be lost by denitrification, partly in the form of NH_2 and caused pollution of atmosphere, and partly nitrate ion can be immobilized by microorganisms. Unlike ammonifiers, there are few nitrifiers in soil as they require special ecological conditions. Major factors on which the abundance and activities of nitrifiers, to include the quantity of nitrates, depend on are as follows: presence of oxygen, soil pH, quantity of organic matter, humidity and heat. From the agricultural point of view, biological nitrification is a beneficial process; abundance of nitrifiers and their activity are often used as soil fertility index.

Denitrification is a process of nitrate reduction under anaerobic conditions in soil. Depending on the soil conditions, plant species, activity of microorganisms and agro technical measures, nitrates get involved in further transformations (reduction) in many different ways. The nitrate reduction process is called denitrification. If the soil is covered with vegetation and if there is enough oxygen and water, most part of nitrate nitrogen is taken up by plants and microorganisms. However, at deeper layers of soil, in too humid and compacted soil as well as in the inner part of structural aggregates under anaerobic conditions, the following reduction of nitrates takes place:



The activity level of microorganism's denitrificators is highest in a neutral environment (pH 6 – 8). The optimum temperature for denitrification is around 25 °C; however, the process may have different intensity at temperatures ranging from 5 to 75 °C.

From the aspect of matter cycling, true denitrification is a beneficial process since the reduction transforms nitrates into elemental nitrogen thus enabling nitrogen fixators to function. From the agricultural point of view, true denitrification is a detrimental process since it leads to the loss of nitrogen from the soil. Losses are increased in poorly aerated soils, after the excessive application of mineral fertilizers, in compacted soils and soils with no vegetation cover. From ecological aspect, denitrification is also detrimental since it contributes to the increase of nitrogen – suboxide in the atmosphere, which further contributes to the reduction of ozone layer.

Fixation of nitrogen from air is done by microorganisms divided in two groups: those living in association with plants and the free ones. A total global biological fixation of nitrogen by all types of organisms is estimated at 175 million tons annually, of which nearly 80 million tons by legumes. The free nitrogen fixators from air are cyanbacteria, Azotobacteraceae (aerobic fixator) and *Clostridium* (anaerobic bacteria, less represented in agricultural soils). Among symbiotic fixators, there is *Rhizobium* – a type of bacteria living in a symbiotic relationship with legumes (family of Fabaceae: clover, alfalfa, bean, pea, soybean...), in the nodules of their root, and converts the atmospheric gas N_2 into NH_3 . The resultant ammonia is used by legumes to form amino acids and proteins, whereas products of legume photosynthesis provide the *Rhizobium* bacteria with energy necessary for growth and further fixation.

Sulfur Cycle

Sulfur is a nutritive element essential to all living organisms. Animals use it in the form of amino acids; plants take it up from sulphatic anion (SO_4^{2-}), and microorganisms from various organic and inorganic sources.

Sulfur is found in atmosphere, water and soil. In the atmosphere, sulfur is found at the bottom layers in the form of sulfur oxides: sulfur dioxide (SO_2) and sulfur trioxide (SO_3); sulfates attached to dust particles and water droplets; and, in the form of hydrosulphide (H_2S) and its organic evaporable compounds. Sulfate ion (SO_4^{2-}) is the most significant anion in rainwater, but it is also one of the most significant anions in the sea. The marine sediments may contain significant concentrations of reduced organic compounds of sulfur (e.g. sulfides, S_2^-)

In the soil, sulfur is represented in organic and inorganic compounds as well as in elemental form. It comes from primary minerals, plant and animal microbiological residues, water, atmosphere and mineral fertilizers.

Microbiological transformations of sulfur compounds in soil comprise three phases:

1. mineralization of organic compounds to hydrosulfide (H_2S),
2. oxidation of hydrosulfide through elemental sulfur to sulfates, and
3. reduction of sulfates.

The reduction of sulfur may be:

- assimilative reduction – its purpose is to bring sulfur inside a cell and
- dissimilative reduction – its purpose is to obtain energy.

Phosphorus Cycle

Phosphorus cycle is less complex than nitrogen cycle. It is a limiting factor for the primary production in aquatic ecosystems. In soil, it is found in organic and mineral parts of it. It is the major constituent element in nucleic acids and cell membrane, and is also found in bones. Plants assimilate it in the form of phosphate (H_2PO_4^- , HPO_4^{2-} and PO_4^{3-}). In acidic soils together with Al^{3+} and Fe^{2+} it builds forms that are less soluble, just like it is the case with Ca^{2+} in soils formed on carbonate substrata. There are two groups of microorganisms that have the ability to release phosphate:

- phosphorus mineralizers – release phosphates from the organic compounds of P and
- phosphorus mobilizers – release P from inorganic compounds (e.g. from phosphate and apatite minerals).

Nutrient Regeneration in Terrestrial and Aquatic Ecosystems

In order to maintain the production found in certain ecosystems, nutrients have to be regenerated within the system. Namely, the rate of nutrient inflow from the outside is not usually sufficient to maintain the current production volume within it. The nutrient regeneration into forms suitable for their repeated assimilation is the key to understanding the ecosystem functioning regulation.

The nutrient regeneration processes in **terrestrial ecosystems** occur in soil through the processes of mineralization of organic matter and weathering of parent rocks. A proper and balanced supply of nutrients in soil is important for several reasons. A nutrient surplus in soil as an effect of improper fertilization may result in nutrient loss which could lead to contamination, eutrophication of water and air pollution. A nutrient shortage is the synonym for excessive exploitation of soil over a long period of time, which leads to reduced quantity and quality of the yield.

Mineralization represents a biochemical decomposition of organic residues in soil to the level of water, CO₂ and mineral matters (nutrients). Decomposition of organic matter and its mineralization produce simple primary forms of nutrients (N, P, K, Ca, Mg, and S). The soil fauna, during the process of decomposition of organic matter, plays the preparatory role. By fragmenting plant litter and increasing the active surface for microbiological attack, as well as by distributing organic residues in soil matrix, the soil fauna improves the ability of decomposing microorganisms to decompose organic residues. The microbiological decomposition of organic detritus in soil, whose highest rate occurs at the top layer of soil, has the effect of releasing CO₂ into the space between the soil particles, and ultimately into the atmosphere. There are 5 major products of decomposition of the plant and animal detritus in soil:

1. CO₂ – level of decomposition is determined based on the quantity of produced CO₂.
2. Heat or energy – released energy is taken up by the soil microorganisms.
3. Water – is released as a product of oxidation of the organic carbon compounds via several enzymes.
4. Plant nutrients –S, N, P, K, Ca and Mg are released as well as some micronutrients. This is one of the main goals of the application of organic fertilizers (along with improvement of the water, air and thermal properties of soil). Some of the released nutrients may be immobilized again or fixed through the collective microbiological and chemical reactions.
5. Humus – biochemically transformed soil organic matter. This is a combination of transformed plant and animal detritus in soil, as well as resynthesized microbiological tissue that is resistant to microbiological activity.

The rate of decomposition of the soil organic residues depends on: pH, temperature, humidity, oxygen content, type of soil. Sandy soils easily dry up slowing down the rate of decomposition. On the other hand, soils prone to mineral decomposition and having a high content of Al^{3+} and Fe^{2+} oxides and low adsorption capacity, have in general poor fertility, they facilitate decomposition processes and building of a stable organic matter of humus. The minimum or zero tillage system protects pedofauna. As this system of tillage shows a tendency to maintain the soil temperature and humidity stable, the population of microbes also benefits during this period. The optimal water and air conditions for microbiological activity are reached when soil pores are filled with 60 % water and 40 % air. Under anaerobic conditions, denitrification processes increase. Optimal temperature for microbiological activity depends on climate zone, e.g. for Canada it is around 20 °C and Australia around 35 °C.

Weathering of rocks is a physical (disintegration) and chemical (decomposition) process of decomposing that occurs at the top layer of the Earth's crust – weathering and pedosphere. Decomposition of minerals releases K, Ca, Mg and Fe. Weathering naturally occurs where surface water (carrying dissolved CO_2) enters the soil. A repeated freezing and thawing of water in the cracks breaks the rock into smaller pieces increasing thus the surface area of the rock that is exposed to the activity of chemical factors. Physical (mechanical) weathering is also caused by plant roots and wind. Chemical weathering occurs via several processes: water dissolves soluble minerals in the following sequence – chlorides and nitrates first, followed by sulfates and carbonates and, finally silicates; *hydration* – penetration of water molecules into the structure of mineral; *hydrolysis* in which water reacts in dissociated state where aggressive H^+ extrudes accessory cations (K^+ , Na^+ , Ca^{2+} , Mg^{2+}) from the structure of primary minerals which weakens the crystal lattice and causes disintegration of minerals. The weathering process releases certain elements – plant nutrients, from the primary minerals (calcium, magnesium, sodium, potassium) which is then followed by the reorganization of the remaining oxides of Si^{4+} , Al^{3+} and Fe^{2+} into new secondary minerals. The nutrient regeneration from detritus (product of weathering) also occurs through the activities of various groups of organisms that feed on detritus (worms, snails, insects, bacteria, mushrooms).

Igneous rocks such as granite and basalt contain 0.3% phosphate and 0.1% sulfate and zero nitrogen. Therefore, weathering provides soil with very little of these nutrients. Precipitation inputs and nitrogen fixation are also low, so that the plants' production depends on the rate of nutrient regeneration from detritus and decomposition of organic matter.

Many tropical soils are infertile due to low content of clay which results in poor retention of nutrients. However, majority of tropical forests are characterized by high productivity owing to fast regeneration of nutrients from detritus under the

hot and humid conditions, rapid decomposition of organic residues, rapid uptake of nutrients from the surface layers, and efficient retention of nutrients by plants.

Sediment is the main source of regenerated nutrients in **aquatic ecosystems**. The sediments in aquatic ecosystems may be compared with the layer of detritus in soil in terrestrial ecosystems. However, there are two main differences between them:

1. Regeneration of detritus in soil occurs in the vicinity of plant roots while aquatic plants assimilate nutrients from water in the photic zone that is often far away from the sediment, and
2. Decomposition of land detritus occurs rapidly under aerobic conditions, whereas aquatic sediments are often anaerobic slowing down the majority of biochemical transformations.

The primary production in aquatic ecosystems depends on the rate of assimilation of regenerated nutrients within the photic zone (plants assimilate regenerated nitrogen at a very high rate, especially in nutrient poor waters). The maintenance of high production depends on the distance between the sediment and photic zone, or on high turnover between bottom and top layers, at least temporary if not permanent.

In shallow waters sediments play an important role in nutrient regeneration. Temperature stratification prevents vertical mixing of the water in aquatic ecosystems. Vertical mixing of the water is necessary for the introduction of nutrients regenerated from the sediments into the surface water (photic zone) where the primary production takes place.

In rivers and streams the nutrient regeneration is influenced by the movement of water. In rivers, the organic matter is sometimes very quickly transported downstream (nutrients regenerated at one location may be assimilated at another). In rivers and streams the input of organic material is more of allochthonous than autochthonous origin (it mainly comes via erosion from the land). In the upper part of the rivers, these are mainly larger particles of organic matter (over 1mm), which while moving downstream get decomposed into fine particle organic matter, and ultimately into dissolved organic matter.

River deposits found in deltas of large rivers and distributed by ocean currents play a significant role in supplying marine plankton with nutrients. It is estimated that a half of the total O₂ on Earth is produced exactly by the photosynthesizing plankton that feeds on the Amazon River deposits.

3. ENDANGERING THE ENVIRONMENT

Any ecological system is exposed to various occurrences that continuously challenge its functioning. Some forms of these challenges, such as natural disasters and wars are as old as the human civilization. They had occurred in the past, and they occur at the present time and will occur in the future. However, the biggest modern time threats to the environment are degradations caused by anthropogenic activity. The predominance of man-made degradations of ecosystems is a tendency that characterized the late twentieth century. According to the Millennium Assessment, structure and functioning of ecosystems worldwide changed in the last fifty years of the twentieth century more rapidly than in any other period of human history.

A severe ecological crisis of this civilization is built on the profitable modern technology utilizing natural resources to the level of total exhaustion and excessively polluting the environment. Indeed, human interactions with natural systems, mainly through the exploitation of natural resources, are necessary for their survival on the planet. However, once a natural resource has been placed under human management, the balance of natural ecosystems gets disturbed. This condition can be either balanced at some lower level, or extended through further degradation of the ecosystem functions.

The most common anthropogenic causes of pollution of air, water and soil include: large-scale industrialization, inadequate application of chemicals in agriculture (pesticides and mineral fertilizers), climate change, deforestation, facilities of production and utilization of nuclear energy, use of radio-active isotopes in various researches, chemical and nuclear waste, oil industry, production plants for paints, varnishes, plastic, as well as storage facilities for hazardous materials.

An average European uses four times as much resources as an average African, three times more than an Asian, but only one half of the American, Canadian or Australian. In the EU member countries in 2007, about 8.2 billion tons of various materials were consumed (State and Outlook of the European Environment Report - SOER, 2010). The structure of this consumption is as follows:

- Various mineral resources 52%,
- Fossil fuels 23%,
- Biomass 21% and
- Metals 4%.

Since the industrial and energy facilities tend to concentrate in the vicinity of natural resources, they attract people from the rural areas thus accelerating the process of urbanization as well as the process of ruralization of the town outskirts. They burden the ecosystem to a significant degree by affecting its most vital functions. As an effect of such pronounced industrialization, we have the exhaustion of resources on one, and high level of water, air and soil pollution on the other side. This way, large amounts of harmful agents in the form of gases, various solid materials, various types of radiation, harmful liquids, noise, heat, overpopulation..., get accumulated in the environment. In parallel with this, we have an uncontrolled demographic growth in the poorest parts of the world, so that as early as in 2020, the current world population of 7 billion will reach the level of 10 billion people who will need food and at least minimum conditions for life and further development, i.e. survival.

Article 2 of the International Law Association Rules adopted in Montreal in 1982, reads as follows: *'Pollution' means any introduction by man, directly or indirectly, of substances or energy into the environment resulting in deleterious effects of such a nature as to endanger human health, harm living resources, ecosystems and material property and impair amenities or interfere with other legitimate uses of the environment.*

TYPES OF THREATS TO ENVIRONMENT

Numerous and various forms of degradation are threatening the environment. All forms of degradation (by type, source, and location) threatening the environment can be divided into two basic groups: natural and technical/technological. In addition, there are war forms of environment degradation manifested during the war activities and man-made natural disasters for war purposes (Ciganović, S., 1980). The occurrences causing degradation of ecosystems are numerous:

- Natural disasters with catastrophic effects (earthquakes, landslides, wildfires, floods, high winds, hail, snow avalanche, etc.);
- Technical–technological accidents and fires with catastrophic consequences (nuclear accident in Chernobyl, explosions and accidents in chemical industry, petrochemical plants and other industries), and
- Endangering to the environment (air, soil and water) by harmful, aggressive toxic and hazardous materials, inputs and final products during their production, transportation, storage or use.

Natural Disasters

A natural disaster is the effect of natural hazard or emergency state occurring without man's will. Natural disasters include earthquakes, floods, droughts, erosion processes, landslides, hail, blizzards and high winds (tornados). According to the Millennium Assessment, the annual economic losses caused by extreme occurrences have multiplied ten times since 1950, and in 2003 amounted to around \$ 70 billion, of which natural disasters (floods, fires, storms, droughts, and earthquakes) are accountable for 84%.

Seismic Disasters

The group of seismic disasters includes earthquakes and landslides whose activities cause changes in the appearance of landscape, i.e. of the set of abiotic factors having a negative impact on life itself in the exposed ecosystems.

Earthquakes have been the inherent part of the Earth's evolution since the beginning of its existence to this date. According to the cause of origin, earthquakes are divided into: tectonic, volcanic and collapse. The Mediterranean area is naturally one of the seismically most active regions in the world (the area of subduction of

the African plate underneath the European plate). It is characterized by relatively frequent earthquakes with shallow focus, whose effects are often devastating for the living world.

Depending on their magnitude, earthquakes produce different effects. The psychological effect is manifested as fear or panic. The mechanical (devastating) effect is reflected in damaging and demolition of housing facilities, cultural buildings, roads and other communication means, infrastructure, bridges, etc. The geomorphic effect (change of landscape features) is reflected in the change of the existing habitats (formation of new lakes, change of river course, floods, change of water level in water wells, formation of cracks on the land surface, new landslides and activation of the existing ones, destruction of cultivated plants). The chemical effects relate to damages on nuclear power plants (Fukushima, Japan 2011) and chemical plants leading to emission of pollutants and threatening the environment.

The **landslides** are numerous in our country and it can be stated that there are a very few areas that are landslide-free. The landslides and inrushes are the occurrences where large amounts of land move due to its instability caused by natural or geologic activities, or as a result of man's activities such as construction and other land involving interventions. They are typical for rural as well as for the suburban areas where developing takes place on unsuitable surfaces and with no relevant permits. The harmful effects of landslide are numerous: they threaten man and his property; natural habitats; they reduce the surface of agricultural land; destroy planted crops and forests; jeopardize sources of fresh water and water accumulations; disrupt road, railway and other communication means; threaten the towns, industrial plants, etc.

Rehabilitation of landslides and their effects is one of the most difficult tasks in civil engineering and the community in general. However, landslides do not cause serious environmental consequences unless they occur in combination with other disasters such as floods or earthquakes. The rehabilitation efforts and preservation of environment in such situations are even more complex.

Meteorological Disasters

Meteorological disasters are occurrences in nature and man has a very little possibility to influence upon them, but is capable of preemptive action in the sense of reducing their negative impact on the environment. Such disasters are occasional, however, they threaten lives of a large number of people, cause substantial material damages and degrade environment. The meteorological disasters with negative impact on the environment include intensive discharges of electricity, extremely large quantities of rainfall, hailstorms and strong winds, heavy snow, ice, fog and wind.

Wind is the movement of air masses from the area of high to the area of low air pressure. Its velocity ranges from 10 to 50 m/s and based on wind velocity and intensity, the territory of our country is divided into three zones:

- I zone – medium strong winds, extends over the continental part of the country,
- II zone – northern flatland parts of the country, and
- III zone – strong north winds (bore) in the mountainous and Mediterranean regions.

Wind is one of the most common natural disasters in the world. It is occasional as a meteorological occurrence but may cause a huge number of casualties and material devastations in a short period of time. Well known are the enormous material damages and often casualties caused by wind storms or hurricanes, especially in the area of the Great Plains in the United States.

Winds are always stronger over the sea due to a lesser friction – oceanic winds. Thanks to these winds, there is a rotation of dry air from the land facilitating evaporation and moist air above the ocean. Winds may be seasonal (sirocco and mistral) and daily (a breeze from land to sea).

Hailstorms are another frequent natural disaster in our country. The hailstones may be 5 to 50 mm large in diameter and upon impact may cause damages to buildings, plants and animals. This way they cause huge damages to all agricultural crops, especially fruit and vegetables.

Floods fall within hydrological disasters. They cause most material damage and ecological effects among all above mentioned disasters. According to the Millennium Assessment of Ecosystems, the incidence and impact of floods and wild-fires have considerably increased in the past 50 years, partly due to the changes in ecosystems. Good examples are the increased exposure of the coastal population to tropical storms after the mangrove forests have been felled and downstream floods caused by the change of land use in the upper Yangtze River.

Main flood causes include:

- Degradation of forests caused by improper management that reflects through the conversion of agricultural land, felling and destruction of shrubbery; (forests are large water consumers and protect the soil which accumulates water from erosion)

- Insufficient cleaning of deposits in watercourses and accumulations, (causes mudding of the riverbed and reduces the outflow profile and flow velocity)
- Climate change within our geographic area, (high incidence of extreme rainfall quantities over a short time interval or extreme temperatures and winds most likely caused by human activities)
- Lack of flood-control levees – (in Bosnia and Herzegovina, with the exception of the Sava River along whose banks the Main Sava's flood-control embankment is constructed and calculated based on a 100 year data on water level, all other watercourses represent a pronounced threat in terms of flood)
- Large and small-scale wildfires that destroy forests and plants, enabling in that way the climate changes, erosion and landslides to occur.
- Soil erosion facilitated by the above mentioned forestry management (tree felling) and inadequate utilization of agricultural land,
- Inadequate selection of field crops for sloped terrains as well as cultivation of soil on slopes, contribute to the ablation of soil particles and hence reduction of soil depth. Such occurrences consequently make impact on flood occurrence since soil acts as a sponge (retaining water) and reduces the outflow velocity, i.e. concentration of water at the lower regions
- Man –in addition to the indirect impacts, anthropogenic influence is mainly related to the incompliance with legal provisions and regulations, as well as poor knowledge of natural principles and poor management of natural resources in general.

Particularly devastating floods are caused by dam collapse or abrupt spillover/discharge of water from the accumulations. These floods are usually of a massive scale and they jeopardize the neighboring area population, contaminate the soil and destroy the crops. In Europe and the world many such accidents happened which is a warning to the humanity to take a closer care about preventive and security measures while building artificial accumulations. For example, the 1920 earthquake in China had caused the formation of a water accumulation which was subsequently breached by the water kinetic energy in several places destroying thus the surrounding settlements. In 1938, the Chinese deliberately tore down the Huan Joa river's embankment in order to prevent the Japanese troops from advancing, causing the drowning of 890,000 people and leaving 12.5 million people homeless. In Spain, in 1950 the Vega de Tera dam on the Tera River broke killing 1,200 people. In 1959 the collapse of the Malpaset dam in France, caused death of 500 people. In Italy in 1963, a flood wave formed by the spillage over the Vaiont dam flooded and

devastated the town of Longarone, killed 1,540 and left 150,000 people roofless. (Đarmati and Jakoljević, 1996).

Technical-Technological Threats to Environment

Nuclear power reactors, besides the application of nuclear energy in various means of mass destruction (nuclear missiles), are increasingly becoming a source of energy as the reserves of liquid fossil fuels are estimated to be exhausted by 2025, and solid fossil fuels by 2400. A total of 442 nuclear power plants currently generate around 15% of the world electrical power. France, for example, produces $\frac{3}{4}$ of the total electrical power in nuclear plants. In our close neighborhood there are 10 operational, and another 10 nuclear power plants under construction. The closest nuclear power plants are: Cernavodă (Romania), Krško (Slovenia), Bohunice (Slovakia) and Kozloduy (Bulgaria).

The utilization of nuclear energy for civilian purposes raises two issues: security of nuclear facilities and contamination of environment with nuclear waste. Discussions concerning the former one were intensified especially after the accident in Chernobyl. In some countries, the information about actual safety of nuclear plants and the possibility of nuclear accidents and their effects is something that nobody talks about, whereas in some other countries in the region of OECD, the construction of new nuclear power plants as well as the exploitation of the existing ones were placed under the moratorium (Austria, Denmark, Italy, Sweden, Switzerland). The discussions on nuclear plants security have particularly been actualized after the 2011 Fukushima nuclear accident in Japan, in which the earthquake and tsunami effects caused damages to the nuclear reactor cooling system, fire and leakage of radioactive water. Only the enormous efforts of the employees prevented an even bigger catastrophe. However, the entire situation involving high tension and anticipation compelled the governments of a number of countries to double-check the security of their nuclear power plants and reconsider and review the justifiability of investments into this type of energy sources.

Storage of nuclear waste - Nuclear waste consists of fission by-products – splitting of nucleus U-235 (cesium, strontium, and krypton) or radioactive isotopes. The radioactive isotopes have long decay half-life – hundreds and thousands of years, which makes them one of the major environment polluters. Once a nuclear power plant has completed its operation (from 20 to 40 years), it leaves behind some high-level radioactive materials in the form of liquid or sludge, and some low-level radioactive materials in the form of reactor iron, pipes, toxic resin, water. The issue of storing the radioactive materials (damp sites, „graveyards“) is very complex, expensive and still unresolved in a number of countries worldwide. France currently has the best method for storing the nuclear waste, where since 1978 nuclear waste

is being incorporated in especially casted glass vessels that are then put into sealed containers and buried into special trenches deep under the ground surface. Usually, the uninhabited and inaccessible locations are selected for disposing of radioactive waste.

Ionizing radiation may be of either electromagnetic or corpuscular nature. The former group includes X and Y rays, while the latter comprises electrons, protons, positrons, neutrons (nucleus of helium-alpha particles) and heavy ions. Particles bearing electricity perform direct ionization and are therefore called *direct ionizing radiation*, while neutrons are electro-neutral particles and perform *indirect ionizing radiation*. The ionizing beams are used for diagnostic and therapeutic purposes in both radiology and nuclear medicine. Today, the sources of ionizing radiation include X-ray devices, linear accelerators, and isotope devices. Other sources of ionizing radiation are natural and artificial radioisotopes. Small doses of ionizing radiation affect genetic material in the sense of genome mutation. What doses are minimal is a question scientists cannot yet answer.

The protection from ionizing radiation in our country is still being performed based on the Law on Environment Protection and other by-laws, while a systemic examination of the contents of radionuclides (radioactive elements) in the environment across the country is required. For the purpose of being able to make timely decisions concerning the environment protection on the entire territory of Bosnia and Herzegovina, it is necessary to establish a *monitoring system*.

Chemical industry and accidents - The toxicology uses terms such as poisons, toxic matters – toxicants, hazardous substances, chemical agents, etc. Poison is a substance of synthetic, biological or natural origin and its derivatives which when introduced into or in contact with an organism can injure the health and destroy life, be it of the humans, animals or environment. According to the Environmental Protection Agency (EPA) data, there are about five million known chemical substances, and at the global level, another 500 to 1,000 new chemical products are synthesized every year.

The accelerated economic development, particularly the development of industry, regularly causes accidents, i.e. undesired and unexpected happenings. The level of intensity of accident risk depends directly on the level of industrial development. This particularly refers to the regions and industrial basins where the so-called dirty technology (petrochemical and pharmaceutical industries, energy production, etc.) is located and operates. The predictability of accidents is not reliable, and yet these happenings are not coincidental to the extent which does not allow any forecasts or preemptive actions. On the contrary, many accidents can be mitigated if not avoided, which depends solely on human behavior. The most often accident causes include: "force majeure" (technical-technological parameter and its downsides), negligence (man and his weaknesses), sabotage and diversion.

Chemical contamination of environment may be the consequence of accidents in:

- production and other plants producing or using harmful materials as inputs. The consequences of the 1976 Seveso disaster (*north of Milan in the Lombardy region in Italy*) compelled the EU countries to adopt the so-called „Seveso Directive“, which serves as a useful document for prevention, preparation and response to chemical accidents, not only for the EU countries, but those outside the community as well;
- warehousing facilities for industrial and other hazardous substances;
- transportation of hazardous substances; Discharge of oil from tankers transporting petroleum cause damages to aquatic and coastal ecosystems. The oil spills reduce the water evaporation total area (most humidity comes into the atmosphere from the evaporation of seawater), cause death of a large number of fish, birds and dolphins, and certainly affects the esthetic impression. According to the provisions of the International Convention on Oil Transportation, any tankers whose capacity is bigger than 40,000 tons, as of March 1, 1985 should have the protection systems with inert gas as well as the freight stabilization system;
- dumpsites for hazardous waste. A wrong selection of the site for disposal of waste coming from chemical and industry in general may have very serious consequences.

Chemical accidents, no matter where they happen, have the polluting effect on the environment. In all previous cases of chemical accidents, most attention was paid to the acute issues of protecting and saving people and material assets while the ecological aspect was neglected. Chemical substances get into the soil and watercourses affecting and doing so not only their flora and fauna but indirectly the humans who use these organisms for food.

Industrial fires as causes of chemical pollution – Since the times immemorial, man has faced the risks of fire, and uncontrolled fire powers causes fear of highest intensity. Depending on the type of fire affected facilities, distinction is made among residential area, commercial, inflammables and explosives storage, and forest and field fires. Industrial fires cause huge damages as the fire engulfs machinery and equipment, inputs, semi-manufactured products. The highest risk for the environment is related to the fires started in the paper and cellulose, paints and varnishes, oil processing and rubber industries. The fires in warehouses of inflammable and explosive materials pose a particular threat due to large quantities of material concentrated in a relatively small space. In this sense, the oil and wood industry are especially dangerous. A fire involving large quantities of inflammable materials is hard

to extinguish and represents a long-lasting seat from which fire, under favorable weather conditions, may spread to the apartment buildings.

Solid Waste Disposal

Even though at the time of Julius Caesar, in 48 BC, there was an edict that banned street littering, the first waste skips were installed in Paris only in 1884. The permanent development of industry, urbanization and growth of urban population caused the increase of solid waste quantities and thus the issue of its removal (disposal). There are several types of waste:

- Solid waste – any useless object or material its owner disposes of;
- Municipal waste – is solid waste produced in urban zones and mainly consisting of the so-called residential and commercial waste. The significance of this type of waste is best illustrated by the information that in the mid 70s of the past century in the USA around 30 billion various bottles, 50 billion cans, more than one million TV sets, 9 million cars were disposed of annually while in France, at the same time, waste contained 4 million tons of paper which is equivalent to a forest of 68 million trees, around 800 thousand tons of glass, 500 thousand tons of various metals and 400 thousand tons of synthetic materials;
- Industrial waste – any waste material produced by industrial processes, which has no harmful effects on the environment and human health, i.e. has no hazardous ingredients;
- Medicinal waste – includes all waste produced by health facilities;
- High-level radioactive waste.

The increase in consumption goes along with better standard of living. Almost everything is bought, consumed and disposed of, and everything used or worn out is called – garbage or waste. Nearly 150 billion tons of garbage, from urban areas alone, which is the annual amount collected in the Western Europe, could fill 1,000 football grounds 30 m high. According to the report by OECD (Organization for Economic Cooperation and Development) - with the membership of 26 most developed countries in the world - production of waste in these countries in 1990 amounted to 9 billion tons. Figuratively speaking each European “produces” annually around 500 kg of garbage, or around 1.5 kg per day, or somewhat less than 100 grams per hour.

The composition of that garbage goes looks as follows:

- major part, about 30% is organic, consisting mainly food wastes,
- about 28 % is paper and cardboard,
- 16% plastic,
- 8 % glass,
- 4% aluminum and steel, and
- remainder is the so-called „hazardous waste“ (batteries, car batteries, medicines) and bulky waste which includes discarded furniture, large appliances, computers, mattresses, etc.

With this rate of waste production, the entire planet would have been buried under garbage and waste materials had it not been for recycling. Each year, more than 55% waste undergoes the special recycling processes, gets a “new life” and goes back into the vicious circle: production-consumption-disposal-recycling. In Europe around 80% disposed aluminum, 75% steel, over 50% paper, around 45% plastic are recycled annually. A part of organic waste gets processed into mineral fertilizers while the rest is left to rot at specially designed dumpsites. The overzealous advocates of ecology support recycling of everything but plastic. They believe it is almost impossible, or otherwise too expensive and thus not cost-effective, to separate plastic by types: PVC, polystyrene, etc. It is recycled all together, and the outcome mass of poor quality is used to manufacture products that have very short utilization life, hence they end up back in garbage very soon. For this particular reason, the Greenpeace organization strongly advises: “Do not buy anything in plastic packaging material!”

In order to more easily and less painfully get rid of waste and garbage, as well as to make recycling faster and cheaper, many countries have in the recent past adopted a system of waste separation, i.e. disposal. What does it mean? Instead of installing one dumpster for all kinds of waste and garbage, several dumpsters are provided, and each one is designated for a specific type of waste. Dumpsters and garbage bins are nowadays available in almost all parts of the world. At the global level, they are the protagonists in any urban landscape, who can tell us a lot about culture, esthetics and mentality of a country and its people. Though nobody wants them in front of their houses or gardens, they are accepted as a necessary evil without which all streets and squares would be covered in garbage.

Disposal of waste in urban areas in the way which provides environment protection, regardless of the adopted Regulation on Criteria for Selecting the Location and Arrangement of Waste Landfills in our country, has not yet been properly solved. Most our landfills are located in the vicinity of settlements, without any prior preparation of land, and present a constant source of risk to the health of people,

surface and ground waters, soil, air and environment in general. Additionally, due to the citizens' negligence, piling up of waste outside landfills contributes to the formation of wild landfills which are more prone to accidental fires, and represent an extension of polluted territory.



Picture 4. Illegal dumping in the Ugar River canyon

If landfills are located on a porous soil, there is a risk of water basin pollution even at far distances from the landfills. Such solutions contradict Article 11 of the Regulation which stipulates that a landfill cannot be located: less than 500 meters away from the banks of rivers, lakes, accumulations or in their alluvion; less than 1,500 meters away from the cultural monument sites or protected natural spas, food industry; on the soil where the maximum seasonal groundwater level is 2m away from the dumpsite floor, nor on the soils whose permeability is higher than 0,00001 m/s; less than 100 m away from the gas line, oil pipeline, high-tension transmission lines; above built-in installations for artificial irrigation, tunnels, overpasses or shelters.

Possible accidents on the landfills include: fire outbreaks, explosions, smoke and smell from the site, as well as environment contamination. In addition to increasing the risk of fire and explosion, the accumulation of waste materials often cause the appearance of feathery and hairy animals as well as a run of low social status citizens – collectors of secondary raw materials.

Ecological Warfare

In the past several years, the world public has started to pay more attention to the terrifying option of ecological warfare, i.e. the possibility of war activities that would not directly target personnel, but drastically change a man's environment. Such actions could indirectly and in a specific way affect his existence, thus accomplishing certain war objectives. During the Vietnam war forests were destroyed by „Daisy Cutter Bombs“, „Rome ploughs“, spraying with herbicides and defoliants and fire storms too. The fire storms had a dual effect. First, they destroyed natural forest ecosystem, and second, they caused mass suffocation of people being in their proximity due to „disappearance“ of oxygen.

The term „ecological war“ or „ecological warfare“ usually refers to very different forms of destruction of the natural environment. Recently, the term „ecological war“ has been replaced by the new term **ecocide**. This term was derived as an analogy to the well-known term „genocide“, which in its broadest sense implies mass and deliberate killing of people, i.e. ethnic groups. The term „ecocide“ from *oikos*, which is Greek word for home, dwelling place, and *caedere* – Latin word for killing, destroying.

The UN Convention signed in Geneva in 1977, which bans any hostile use of environmental modification techniques, was actually an attempt at defining this problem. The new term «environmental modification technique» was introduced. According to this convention, use of any techniques and procedures aimed at deliberate manipulation of natural processes such as Earth's dynamics and structure, to include its biotics (hydrosphere, lithosphere and atmosphere), which could result in earthquakes, huge tidal waves, disturbed ecological balance, climate change, ocean currents, etc., is strictly prohibited.

IMPACT OF AGRICULTURE ON DEGRADATION OF ENVIRONMENT

Air, water and soil are the three elements of ecological systems that are most frequently and directly exposed to degradation. The agricultural impact on environment is very complex. It comprises several very significant processes, such as:

- conversion of natural forest and grassland ecosystems into agricultural ecosystem;
- damage and disappearance of natural biotopes and landscape elements;

- intensification of agriculture which favors exhaustion of natural fertility and occurrence of various pests;
- eutrophication and pollution of waters due to the application of protection chemicals;
- emission of nitrogen oxides from agricultural land as an effect of the application of nitrogen fertilizers;
- soil cultivation which accelerates the process of mineralization of organic matter and loss of carbon stored in soil organic matter;
- emission of methane related to animal husbandry and emission of methane from rice fields;
- reduced biodiversity in and around agricultural ecosystems;
- degradation of soil;
- erosion of soil;
- water losses caused by the use of natural reservoirs for irrigation.

If we add only the consumption of energy in the industrial production of mineral fertilizers, plant protection chemicals (pesticides), veterinary preparations and hormones, consumption of fossil fuels by agricultural machinery or vehicles used to transport agricultural products at the global level (as a consequence of the ever growing specialized monocrop production at the global level), we shall be able to have a better insight into the complexity of agricultural impact on the environment.

Energy consumption in agriculture is very high. In the United States of America, as much as 12% of the total energy consumption belongs to agriculture. The production of mineral fertilizers burns more energy than it is required for tillage, cultivation and harvesting of all crops in this country. Therefore, it does not come as a surprise that conventional agriculture actually has a negative energy balance.

The ratio between energy input and output varies depending on the type of agricultural production. In traditional and ecological type of production with a large share of human labor and no use of protection chemicals, this ratio is around 10:1, while in greenhouse type of production it goes up to 500:1. Negative energy balance will surely be the biggest limiting factor to conventional production in the future.

The above cited agricultural impacts on environment should be completed with the following ones: excessive hunting and fishing, establishment of aquaculture in ecologically unacceptable way, daily introduction of invasive plant and animal species, genetically modified organisms and food, uncontrolled import of seeds and planting materials.

The costs related to agricultural sector in Great Britain in 1996, incurred due to damages the agro-technical measures caused to water (pollution and eutrophication – a process in which excessive growth of plants burns oxygen from water), air (emission of glasshouse gases), soil (erosion at remote locations, emission of glasshouse gasses) and biodiversity, amounted to a total of 2.6 billion US dollars, or 9% of the average annual gross profit of farms in the 90s of the past century.

Likewise, the annual cost of damage caused by eutrophication of fresh water in England and Wales alone (encompasses factors such as reduced valued of coastal settlements, water treatment costs, reduced recreational value, tourism losses) were estimated at 105-160 million dollars during the nineties, with additional 77 million dollars paid each year for addressing these damages (Millennium Assessment of Ecosystems).

Conversion of Natural Forest and Grassland into Agricultural Ecosystems

Agriculture replaces natural forest habitats by crops. Figuratively speaking, we could say that the ecological stability of rural environment manifests itself through a “combat” between natural forests and meadows on one, and agriculture on the other side. By cultivation, once impassable forests and grassland are turned into agrobiotopes where, depending on the type of agricultural land use, various agro-technical measures as well as heavy machinery are applied (crop rotation, soil tillage, application of organic fertilizers (manure), preparation of soil for sowing, spraying with protection chemicals, irrigation, application of mineral fertilizers (ameliorative, basic fertilization and top dressing), harvesting...)

From the historic point of view, the original nomadic agriculture that continued through the hunter-gatherer phase of human society does not leave any permanent footprint on the landscape, and very soon after it has been abandoned, it reverts back to natural ecosystems of meadows and forests.

The large-scale and far-reaching changes in the natural landscape took place with the appearance of modern sedentary agriculture some 10,000 years ago and led to shaping of a specific rural landscape that is ultimately defined by parcelization of agricultural areas and specific appearance of the countryside and agricultural farms. The neolithic farmers of the north Europe had cut vast forestland areas, creating so a new landscape in which agricultural areas alternate with the forest ones. In the Middle East, they still have the 6,000 years old irrigation canals. In the steep areas of Andes and Southeast Asia, people managed to protect land from erosion and sliding by building terraces, many of which are still in use.

However, the early development of agriculture in the Middle East took a toll. Namely, to this day the conversion of natural into agricultural land and their continuous tillage (first plough in 4th millennium BC) has contributed to the continuous erosion of the Middle-Eastern landscapes and their desertification that is evident in the present day.

Since 1945 to this day, more land has been converted into agricultural than in the eighteenth and nineteenth century together. Cultivated systems – areas in which not less than 30% land is under crops, with crop rotations, animal husbandry of factory type (confined), or aquaculture – now cover one quarter of the total land areas on the Earth.

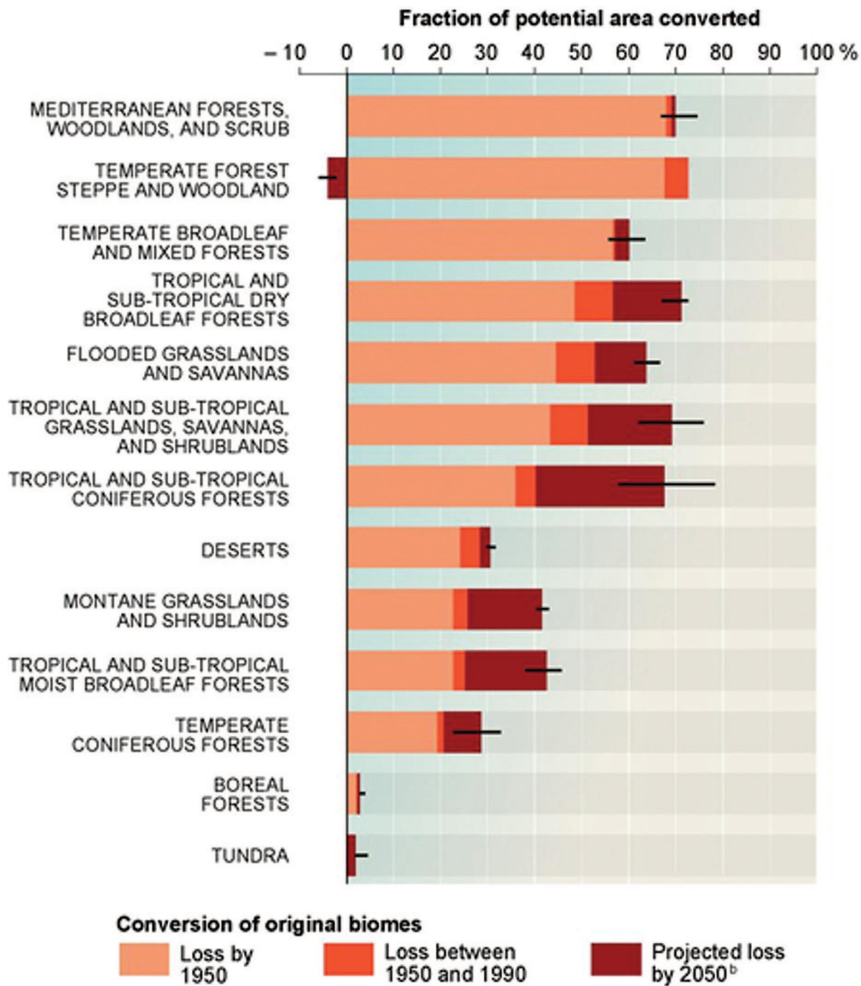


Chart 1: Conversion of terrestrial biomes (communities) into cultivated systems by time intervals, (Millenium Assesment Ecosystems)

Intensification of Agricultural Production and Environment

There were several periods within the development of, as well as approach (understanding of role and objectives) to agricultural production. In the middle of the past century and through the sixties, the Green Revolution wave brought the process of agricultural intensification to its peak. Only after the seventies there emerged some ecological approaches to dealing with agricultural production, which by using the concept of sustainable agriculture tried to reconcile apparently unrecognizable ever growing food demands of the fast growing world population one, and the preservation of environment one the other side. However, we cannot give up on conventional or standardized production as we are still far from providing own population with sufficient quantities of food that meets the prescribed standards of quality. Basic characteristics of conventional agricultural production include application of chemicals, specialization of farms, high production of organic mass per hectare and high input cost (machinery, fertilizers, protection chemicals, energy, etc.).

A family farm represents an independent organizational unit and basic or principal pillar of agricultural production. The members of their own families provide labor; they are in possession of the necessary agricultural land (in ownership and/or leased); they own necessary agricultural machinery. The natural family farms, mostly oriented to fulfill the food requirements of the family, with integrated crop and animal farming, are characterized by a smaller negative impact on environment, relative to the larger, market-oriented farms. These large farms linked to the processing industry (fruit, vegetables, textile, etc.), because of market requirements for a reliable and continuous supply of cheap agricultural products, are resorting to an increased application of protection chemicals thus making a more substantial impact on the environment.

Growing is sometimes performed through a crop rotation on just one land parcel, although in an extremely profitable agriculture, it is not rare to have just one type of crop produced on a parcel year after year (monocrop). The monocrop production, typical for large specialized farms, contributes to the exhaustion of some soil nutrients (typical for that specific crop) reduces soil biodiversity as well as total biodiversity of the agro-ecosystem. This is one of insecurity factors in the sense of continued provision of reliable monocrop yields, especially in case of natural disasters or crop diseases and pests.

Another specific impact of agricultural production on the environment is related to the production of rice on flooded rice-terraces (paddy fields). This farming method represents a significant source of methane (CH_4) emission into the atmosphere. Anaerobic conditions under the water cause the process of oxidation of organic detritus to slow down and remain incomplete, which causes formation of

methane as a product of decomposition. Methane gas mixed with air is one of very explosive glasshouse gases, and may retain up to 20 times more heat than carbon dioxide.

Application of Chemical Fertilizers and Pesticides

The pollution of agro-ecosystems and environment in general is largely influenced by the application of agricultural chemicals. This statement primarily refers to improper use of pesticides and mineral fertilizers reflected in excessive, ill-timed and uncontrolled application, which has not been previously adjusted to abiotic factors (climate, soil and terrain) and requirements of the crop. A particularly serious issue is related to the process of nitrates and nitrites leaching, which get into the soil through mineral fertilizers and acid rains.

The emission of nitrogen oxides (N_xO) as an effect of the application of nitrogen fertilizers (there is also the emission of nitrogen oxides from natural soils due to decomposition of organic matters in the soil) is harmful from two different aspects. It does not cause just the greenhouse effect, but also the reduction of the ozone layer. Nearly 90 % of the global N_2O was formed through the microbiological transformation of nitrate NO_3^- and ammonium NH_4^+ in soil and water.

Generally speaking, the application of pesticides for the plant pests usually has some side-effects, i.e. non-selective action especially onto micro flora and fauna of the soil, retention of the residues of such chemical in soil and crops, change of soil pH values – reduces the content of calcium and magnesium, which all combined has a negative impact on plants and ultimately on humans as their consumers. The ability of soil is reflected in its function as both filter and buffer. This is a reflection of its ability to decompose, immobilize and detoxify pesticides and other potentially detrimental compounds that get in the soil.

Impact of Animal Husbandry on Environment

We have already mentioned environmental damages (contamination of groundwater with nitrates) that may be caused by improper storage and management of manure and effluent from large animal farms. Methane produced by cows' cudging makes up around 16% of the world annual emission of methane into atmosphere. Generally, the animal husbandry sector (mostly cows, poultry and pigs) produces about 37% methane, and this production is either directly or indirectly related to man. The researches have established numerous medical treatments and methods for adjusting animal feed in order to reduce methane production in ruminants.

The expansion of animal husbandry at the expense of forest areas represents a very good example of how man's negative impact on environment may be manifold. Deforestation of large areas of rain forests in the tropics allowed for the expansion of animal husbandry, but caused huge damages to the environment, especially at global level through carbon cycle. This multitude of negative impact reflects through the following occurrences. It is well known that forests are a huge consumer of CO₂ required for photosynthetic production of biomass. At the same time, they are a place for storing large quantities of carbon in the form of wood biomass and soil organic matter. These are the so-called "forest carpets" from the leaves and tree detritus at various stages of decomposition which get accumulated on the surface of forest soil and shallow surface layer of mineral portion of the soil. The conversion of forest into agricultural ecosystem implies deforestation, and along with the loss of trees the potential for storing carbon gets lost as well. In case that felled trees are used for fire, this process releases CO₂. The conversion of forest into arable land for the purpose of acquiring artificial meadows for animal feeding implies the soil tillage which contributes to an increased oxidation of the soil organic matter, which, again results in bigger emission of CO₂ into the atmosphere. Additionally, when such areas are used for animal husbandry being a source of methane emission during the culling process, it is easy to imagine the scope of anthropological disturbances in the global carbon cycle. A particularly significant issue in this whole story is related to the fact that once the natural fertility of a grassland area has been exhausted, the farmers in search of new fertile grassland for grazing their animals resort to deforestation of more forest areas.

Excessive grazing in arid (dry) regions also causes damages to the environment. Large herds of raised cattle have disturbed natural balance of grassland ecosystems. Since it takes vegetation in arid areas quite long to recover after the grazing season, it becomes exposed to erosion.

Agriculture and Biodiversity

Generally, in terms of evaluating nature, there are three different types of biodiversity:

- diversity of biological natural heritage (biodiversity);
- geological diversity (geodiversity);
- ecosystem diversity (natural heritage).

As it is well known, all human activities which directly or indirectly reduce biodiversity result in weakening and making the ecosystem unsustainable, in general. Many activities impact biodiversity and environment as a whole, while causing various forms of change which are apparent in different forms of degradation, devastation and destruction of biodiversity. The most common consequences of such impacts in rural areas include loss of biodiversity and geodiversity, degradation of ecosystems in general and destruction of natural and cultural heritage.

Basic elements that influence the loss of biological diversity are as follows:

- conversion of habitat;
- excessive exploitation of natural resources;
- pollution;
- invasive species;
- climate changes; and
- ecological awareness.

The *Global Biodiversity Strategy* (WRI, IUCN and UNEP, 1992) study, as well as the comprehensive presentation of the *Global Biodiversity Assessment* (UNEP, 1995) state the following causes of biodiversity decrease:

- deforestation and devastation of forests, expansion of agricultural areas, human settlements and aquaculture;
- disruption and fragmentation of the remaining natural ecosystems (new settlements, construction of communication means and other forms of permanent loss of soil);
- destruction or complete decomposition of habitats (soil erosion, construction industry, artificial accumulations, drainage of wetlands and flooded areas, etc.);
- invasion of adventive (alien) species;
- increased agricultural and industrial productions (fertilizers, pesticides, artificial feed, medicines, hormones, biotechnology, etc.);
- pollution of soil, water and atmosphere at local, regional and global scales; and
- global climate change.

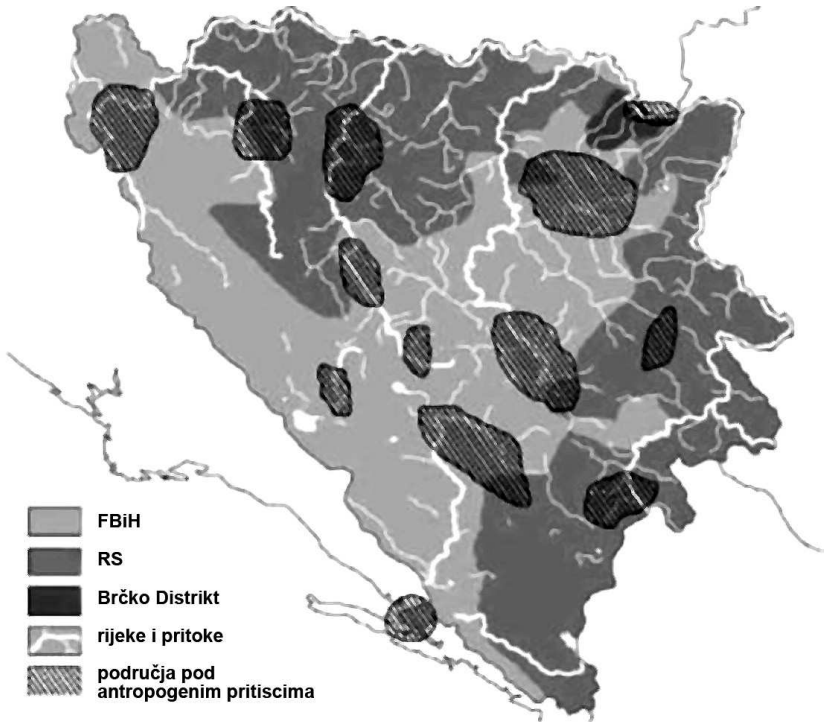


Chart 5. Areas under the pressure by anthropogenic (human) activities (NEAP- BiH, 2003)

The loss of biological diversity results, among other, in the following effects (NEAP, 2003):

- disruption of natural matter cycling processes;
- global climate changes;
- disappearance of organic species and their genetic material;
- disappearance of certain types of soil;
- decrease of economic and esthetic values of space;
- increased poverty (reduced quantity and quality of food, etc.);
- reduced general quality of living, etc.

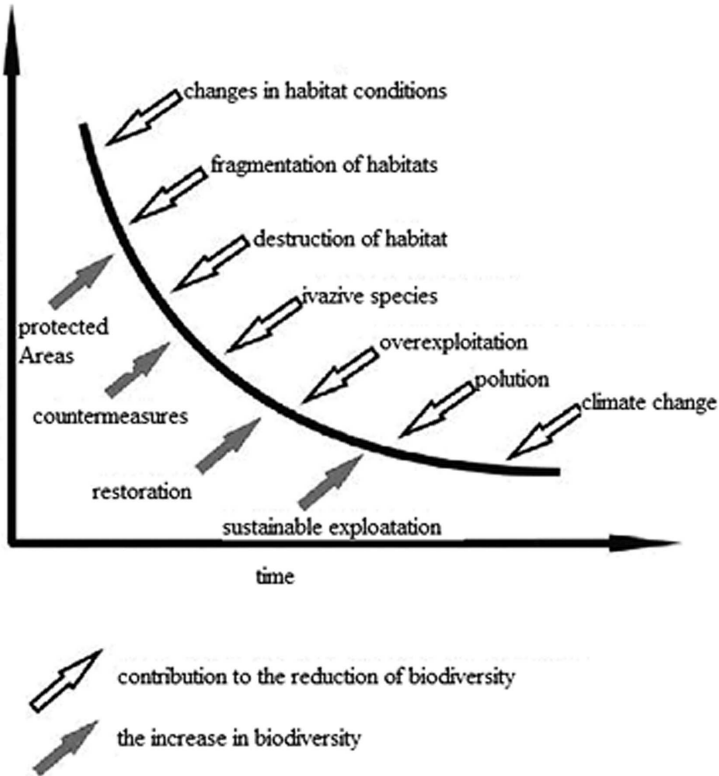


Chart 2: Basic causes of biodiversity reduction and maintenance (UNEP, 1997)

The level of biodiversity in an agro-ecosystem depends on:

- diversity of vegetation within and around the agro-ecosystem,
- continued rotation of crops within the agro-ecosystem,
- intensity of agricultural activities, and
- extent to which the agro-ecosystem is isolated from natural vegetation.

Until the introduction of extensive production, for thousands of years the agriculture had participated in its own way in the preservation of diversity of both species and habitats. However, in the past century the modern extensive agriculture with high inputs of synthetic pesticides and fertilizers, as well as specialized monocrop production, has contributed to the reduction of diversity of genetic resources of crops and animal species, wild flora and fauna species and diversity of

ecosystems in general. Numerous researches assisted in establishing the fact that biomass and biodiversity of the ploughland flora (*Mycorrhizae*) and fauna (earthworm, carabids, spiders, centipedes and bugs) on conventional farms are smaller than in organic fields, which indicates harmful effect of conventional agriculture on biodiversity.

Adventive (alien) species pose a huge problem in terms of threat to biodiversity. The significance of having a solid knowledge about adventive flora, represented by extremely aggressive species, is a basis for taking measures for controlling and preventing their further spreading, as well as preventing the suppression of indigenous flora.

Distribution of neophyte species *Ailanthus altissima* (Mill.) Swingle in Herzegovina is indicative, as it is increasingly expanding and naturalizing and thus suppressing native species by secretion of inhibitory substances (ailanthone) from leaves and roots (Petrović et. al., 2011). Given that *Ailanthus* or Tree-of-Heaven is an invasive species it is necessary to pay attention to the prevention of its further spreading and reduction of the existing populations. Preference should be given to those measures which do not threaten the environment. Tree-of-Heaven is also called "Tree-of-Hell" due to its invasiveness, distribution and difficult control. This is an extremely aggressive species which poses a huge threat to the karst areas of Bosnia and Herzegovina. It threatens almost all habitats, putting pressure on indigenous flora and overall biodiversity of the area.

In general, the change in animal life comes along with the change of plant life in agro-ecosystems where certain wild species lose their natural habitats or their parts, and become forced to migrate or adjust to the new changed conditions. Simply said, wild species in agricultural ecosystems are being replaced by domesticated animals. More than 2 million plant and animal species live on the Earth while only 200 of plants used as human food, and 30 animal species are cultivated and domesticated through agriculture. It can be concluded that the agricultural ecosystem is rather simplified (depleted) compared to the natural ones.

Due to the reduced biodiversity in agriculture at global level, within the framework of the Convention on Biological Diversity, 1996, a special work program was developed, whose goal was to encourage those agricultural practices that would have a positive impact on rehabilitation and improvement of biological diversity (biodiversity). The ability to define a strategy which combines conservation tillage, integrated crop protection and integrated system of plant nutrition, represents the characteristic of sustainable agricultural production.



Picture 6. Invasive species *Asclepias syriaca* L. and *Amorpha fruticosa* L.

SOIL DEGRADATION

The soil is of great importance for the life of entire biocenosis on Earth, and thus for survival of mankind and human civilization alike. Soil represents a source of water and mineral matters for entire phytocenosis, and through it for the rest of the living world, to include man. Lack of nutrients is a synonym for excessive exploitation of soil over a long period, which subsequently leads to reduced quantity and quality of yield. The surplus of nutrients may result in losses due to leaching which further may lead to contamination and eutrophication of water and harmful emission into the atmosphere. Additionally, soil is a habitat to numerous animals and microorganisms and represents a single gene pool. Soil quality depends on the method of its utilization and management.

Agricultural land is a part of land that is used in agricultural production. Efficient use and protection of agricultural land is one of the most important responsibilities of all levels of authority. The Law on Agricultural Land of the Federation of Bosnia and Herzegovina (Official Gazette No. 2/98) states as follows: "Agricultural land is a natural resource of public interest and shall be placed under the special protection and used only for agricultural production, therefore it cannot be used for any other purposes except in cases and under the conditions prescribed by law."

The arable agricultural land includes ploughland, gardens, orchards, vineyards and meadows. Currently available agricultural land is characterized by fragmented parcels, low level of tillage preparedness, low level of drainage and irrigation, monocrop agricultural production and excessive application of mineral compared to natural fertilizers.

According to the data presented in the 2006-2010 Medium-Term Agricultural Sector Strategy for the Federation of Bosnia and Herzegovina, the status of agriculture in Bosnia and Herzegovina is characterized by small and fragmented farms among which the predominant ones are those having up to 3 ha agricultural area, while in the Federation of Bosnia and Herzegovina about 17% of total number of households are categorized as potential farmers where size of their farms averages 5 ha. In the Federation of Bosnia and Herzegovina, size of agricultural area per capita amounts to 0.44 ha, whereas size of arable land per capita is 0.17 ha. In EU (EU-27) average size of agricultural land per farm amounts to 20.7 ha .

Table 2: Structure of farms in private ownership in the Balkans (Boese et al., 2005)

Country	Agricultural households (in 1000)	Companies and family farms with more than 5 ha (in 1000)
Albania	395	50
Bosnia and Herzegovina	290	110
Croatia	450	150
Macedonia	180	60
Serbia	780	160
Montenegro	60	5
Kosovo	200	20

The issue of parcelized land ownership requires a legal framework which would allow maximum freedom in the transfer of agricultural land between the owners and the users, where the market itself would determine the optimal size of the farm. It is necessary to create an environment in which:

- Investors will have confidence in investments;
- Banks will have the possibility to take real estates as mortgage for allocating credits;
- Low interest rate for credit will be ensured;
- Reduce taxes on land sales (current tax is 15%);
- Provide employment possibility to those who will not be involved in agriculture;
- Provide social security to those who may end up with no land;
- Provide capable and professional personnel in real estate business.

In addition to the above mentioned processes of expanding agricultural areas at the expense of natural forest and grassland areas, nowadays we are witnessing a permanent reduction of the existing areas of agricultural land. Namely, previous urbanization, industrialization and uncontrolled expansion of cities and other settlements did not favor the preservation or promotion of the role of agricultural land. It is estimated that Bosnia and Herzegovina loses annually around 3,000 ha agricultural land this way.

Conversion of large areas of quality agricultural land into land for other types of purposes is mostly illegal. This way, land is being increasingly deprived of its role in primary ecological functions, and at the same time it is being degraded. The land degradation causes are numerous:

- conversion of natural land into agricultural,
- methods of tillage of agricultural land,
- conversion of agricultural land into development or industrial land,
- establishment of monocrop landscapes and reduction of biodiversity,
- uncontrolled and excessive irrigation.

Resolving the issue of reclamation of the overburden landfill at the strip mine Gračanica – Rudnik and thermal power plant Gacko, as well as waste material at the mining complex in Stanari must be based on good knowledge of fundamental environmental and plant/geographic characteristics of the recent flora of these technogenous habitats. This knowledge is a prerequisite for taking

measures of recultivation, determining the possibility of exploiting biomass and successful planning of control of these species as potential weeds in established agrophytocenoses (Malić and Kovačević, 2009; Malić et al., 2011).

It is the unquestionable fact that conventional agriculture has caused a series of types of degradation of agricultural land, such as:

- anthropogenic compaction of soil due to the usage of heavy machinery;
- contamination by harmful substances,
- deterioration of biological properties (deterioration of conditions for microbiological activity),
- acidification of soil,
- reduction of humus content.

In addition, extensive agriculture has reduced the crop sequence, reduced or totally excluded the share of legumes, increased the share of field crops (maize and sugar beet), which increases the risk from erosion, pollution of watercourses and canals and reduces the quality of food.

Since soil, along with air and water, is the most represented element of the terrestrial ecosystems exposed to pollution, the positive legal provisions of the Federation of Bosnia and Herzegovina address the issues related to soil protection. The basic documents are the Law on Agricultural Land and the Regulation on Determining Permissible Quantities of Harmful and Hazardous Matters in Soil and Methods for Their Examination. This Regulation defines the substances considered as harmful to agricultural land; permissible quantities of harmful substances in the soil, silt, waste waters, organic fertilizers, manure effluent, mineral fertilizers, soil improvers and plant protection chemicals; pollution prevention measures; control and monitoring over polluted soils; and, prevention, protection and rehabilitation of damaged soils. The objective is to protect agricultural land from chemical and biological degradation and maintain it in a condition that makes it a suitable biome for the production of uncontaminated food.

Soil contamination by harmful substances - A harmful substance is any substance found in agricultural soil in the amount which may temporarily or permanently jeopardize its primary role in food production. Harmful substances include heavy metals and potentially toxic elements (Cd, Hg, Mo, As, Co, Ni, Cu, Pb, Cr and Zn), as well as polycyclic aromatic hydrocarbons (PAH).

Quality of environment in the area of Lijevče polje is increasingly getting affected by various environmental factors, especially the anthropogenic ones (Nedović et. al., 2003). Concentration of heavy metals (Pb, Hg, Cd and Cu) and pesticides (atrazine) is rather concerning. Content of heavy metals in soil and ground water is at a low level (below MPC). Of all heavy metals, copper has the highest concentration (7.46 mg/kg). Atrazine level is below MPC, although the soil contains more of it (0,13 mg/kg) especially on surfaces on which maize is cultivated as monocrop, whereas its content in ground water is rather small which means that there was no leaching.

Various harmful substances, as well as microorganisms found in soil or those having already contaminated soil in some other way, can be indirectly found in the human organism. A common characteristic of heavy metals is their practically unlimited accumulation in biosphere. They are introduced into the food chain mainly through the plants' root and leaf, and since plants take them up from the soil in the amount proportional to the content in soil solution, it means that a plant grown on the soil with increased content of heavy metals contains them in the quantity which may harm the consumer's health – domestic animals and man. Good examples are mercury, lead and cadmium that are absorbed in substantial amounts by some herbaceous plants (cabbage, spinach, kale...) and may subsequently get into the human body through the chain food.

Another important characteristic of heavy metals pertains to them being biogenic elements as well (required by living organisms), which makes the difference between essential or stimulating and harmful concentrations very small.

Table 3: Heavy metal accumulation capacity in some plant species

high	medium	low	very low
lettuce	kale	maize	bean
spinach	cabbage	broccoli	pea
criss	red beet	cauliflower	melon
endive	turnip	Brussels sprouts	tomato
carrot	radish	celery	pepper
	potato	blackberry	aubergine
		strawberry	apple

Erosion is one of the most severe forms of soil degradation. It is particularly pronounced in hilly and mountainous regions. About 78% of the territory of Bosnia and Herzegovina is threatened by the processes of excessive, high and medium intensive erosion. The erosion sources are numerous:

- deforestation and destruction of other types of vegetation,
- irregular treatment of plant cover and uncontrolled grazing,
- abandoned land and irregular tillage.

Extensive tillage causes surface erosion of soil particles. It may be either

- water erosion (pronounced on slopes) or
- eolic erosion (wind erosion) present on flatland areas.

Eolic erosion is the loss of a surface layer of soil by wind. It occurs through a uniform process of material movement of surface soil layer by strong wind activity, usually in arid and semi-arid regions. Deformation of terrain reflects in an uneven movement (relocation) of soil and formation of dunes of eolic sediment. Eolic erosion in our country is particularly pronounced in mountainous regions and Mediterranean part of Bosnia and Herzegovina. Destruction of forests in hilly regions for the purpose of wood exploitation or crop farming has led to disastrous erosion that leaves bare the vast areas of our country.

It is a well-known fact that man's intervention in the agro-ecosystem may cause huge mistakes so that the balance of agro-ecological factors becomes easily disrupted, which ultimately makes a negative impact on plant production. Such examples are numerous. In the Great Plains of the central USA, tillage of the centuries old prairies conducted for the purpose of obtaining more arable land, made soil exposed to adverse climatic effects, causing thus catastrophic eolic erosion. This process was particularly intensive in the thirties of the past century, during several dry years, where high winds created strong sand storms that carried clouds of dust, i.e. clouds of fine soil particles lifted from cultivated land. Ever since then, the issue of land erosion has received close attention in the USA. A part of ploughland had to be replanted by grass; windbreaks were planted and work on various soil conservation measures was activated.

Nevertheless, the area with biggest quantity of eroded soil is located in North China. This is the region of so-called loess plateau, where an average of 250 tons of soil particles from one hectare of land formed on loess, end up in the Hwang Ho River (named after the color of eroded soil particles) every year.

Another similar example is recorded in African and Asian tropics, where deforestation of rainforests and clearing and tilling of savannas for the purpose of obtaining arable land, has led to the exposure of bare land to various climatic impacts. This resulted in a large-scale leaching of nutrients and soil erosion supported by heavy tropical downpours. Ways for removal of these effects had to be sought for here as well. Deforestation of rainforest and ploughing of sandy soils in Brazil has led to the catastrophic erosion effects, caused by heavy tropical downpours and winds.

Unfortunately, such negative ecological effects caused by human error in land management are visible every part of the world. Particularly dramatic effects are related to the huge expansion of the Sahara desert, which is partly caused by improper use of land on its periphery.

DEGRADATION OF FORESTS

Forests as a constituent part of environment play a vital and manifold role in life and survival of the living organisms on the planet. Regardless of that, their exploitation is not getting any smaller. On the contrary, it is going up along with the population growth and advancement of techniques, civilization and culture. A major problem is related to losses due to felling in the areas of rain forests. It is estimated that around 2,600 km² of the Amazon basin rain forest is felled annually, while in Brazil these deforested areas amount to 4000 km². The unique ecosystems of mangrove forests are also at risk of extinction due to felling of mangrove trees for timber as well as for obtaining more area for aquaculture (fishery, shellfish farming, etc.)

In general, deforestation leads to the reduction of rainfall which is again related to the regional climate changes. Since precipitation is essential to the existence of forests, the relation between forest losses and reduction of precipitation may create a feedback effect which, under specific conditions, may lead to a non-linear change in forest cover.

The incidence and influence of floods and wildfires have significantly increased in the past 50 years, partly due to the changes in forest ecosystems. The forest and other types of fire, as well as other occurrences cause the introduction of acid rain inducing matters into the atmosphere. The „acid rains“ are the product of aero pollution and through hydrological cycle they circulate in nature thus polluting all the elements of environment, while causing various diseases of skin tissues, lungs in both humans and animals, as well as in leaves which are the lungs of plants, reducing thus the contribution of photosynthesis.

Forest dieback in our country is caused by aero pollution, no matter whether it comes from our own industrial centers or is „imported“ from the neighboring or some remote European countries by air currents.

All above cited occurrences resulted in poor condition of the forests, i.e. high share of low forests and various degradation forms in the overall resource. The consequences of such situation include insufficient production of biomass and inadequate performance of other forest ecosystem's functions (production of oxygen, protection from imissions, anti-erosion and water-protective function).

In most countries, valorization of forest ecosystems is related to the production of timber and fire wood, which represents less than one third of the total economic value of a forest ecosystem, to include non-market values such as carbon sequestration, protection of watercourses and recreation.

The reliance of poor rural population on the functions of forest ecosystems is rarely measured and is usually not included in valorization (game hunting and collection of forestland fruits, fire wood, animal feed, medicinal plants, timber), consequently it is often omitted in national statistics and poverty assessments, which further leads to the development of inappropriate strategies that do not appreciate the role of environment protection in combating the poverty. These activities used to make up a much larger portion of the overall income of poor families than of the richer ones while this type of income had particular significance during the period of shortage in other means of livelihood.

DEGRADATION OF GRASSLAND ECOSYSTEMS

Frequent fires play a significant role in functioning of a temperate grassland ecosystems (pampas in the south-east of South America, prairies in North America and Asian heath, open pastures of the eastern South Africa or rangelands in south-eastern Australia) because this way grass residues get burned and resultant ashes serves as nutrient to the new plants.

Large grassland plains in North America are now converted into agricultural land, and are very suitable for wheat and maize farming. Only a small percentage of grassland has remained on the hilly terrains. Prior to the arrival of the European colonists, this area used to be home to around 60 million buffalos that were a major source of food to the native Indian tribes. Until 1885, number of buffalos was reduced to 2,000 while today they live mainly in reservations and their total number is approximately 350,000.



Picture 7. Burnt high-mountainous grassland in Herzegovina (it is clearly visible that the road blocked spreading of fire thus preserving the grassland on the other side)

AIR POLLUTION

Air pollutants are various and they get into the air as the products of chemical reactions and combustion of primarily fossil fuels. There are many sources of air pollution: industrial and municipality plants, power plants, motor vehicles, heating plants, individual furnaces; they are released from cooling devices, sprays, from pesticide treated agricultural surfaces, etc. A particularly negative effect on the environment is produced by sulphur and nitrogen oxides. The air pollution has general significance while the consequences include breathing difficulties and possible damages to respiratory organs, unpleasant smell (stench), reduced visibility, source of filth, corrosion of metals, damage to building facades, monuments, damage to plant resources, etc.

Aero pollution may occur in some specific area due to the production of polluting substances or due to their transportation via air currents. The polluting matters come in various types and compositions. Most common ones are carbon and nitrogen oxides, sulfur compounds, hydro carbons, solid particles, etc.

Table 4: Molecular composition and characteristics of key air pollutants

Pollutant	Chemical Composition	Characteristic
Sulfur dioxide	SO ₂	Colorless, heavy gas soluble in water, with harsh, irritating smell.
Particles	Variable	Solid particles of liquid droplets, including vapors, smoke, dust and aerosols.
Nitrogen-dioxide	NO ₂	Reddish-brown gas, soluble in water
Carbon hydrates (and other vaporizable organic compounds)	Variable	Numerous compounds of hydrogen and carbon
Carbon monoxide	CO	Colorless, odorless, toxic gas, poorly soluble in water
Ozone	O ₃	Light-blue gas, soluble in water, unstable, smells sweet
Hydrogen sulfide	H ₂ S	Colorless gas, foul odor like expired eggs, poor solubility in water
Fluorides (e.g. hydrogen fluoride HF)	Variable	Harsh, colorless, water soluble gases (hydro fluoride)
Nitric oxide	NO	Colorless gas, poor water solubility
Lead	Pb	Metal, occurs in early compounds with different characteristics
Mercury	Hg	Metal, occurs in various compounds with different characteristics

The scientists (ecologists and biomedical experts) need to establish a connection between pollutants and the effects they have on human health. The effects are different, and besides being being dependent on the amount and duration of exposure, they also depend on humans themselves. Here is a possible classification of diseases related to the issue of impact of air pollutants on humans: respiratory difficulties and acute lungs functioning problems (breathing), cancer, systemic poisoning (e.g. lead), weakening of the immune system which leads to an increased susceptibility to infections, other types of reduced content of oxygen in tissues (e.g. asphyxia/loss of consciousness due to inhaling carbon monoxide).

Should the limiting imission values be exceeded, polluter is obliged upon the request by inspection authority to undertake necessary steps to reduce the concentrations of harmful and hazardous matters to the permissible ranges as soon as possible, regardless of whether individual polluters meet the limiting values of emission.

The reduction of the level of pollution may be influenced by undertaking the following actions:

- provide a monitoring system for air quality, emission of pollutants (SO₂, NO, CO₂) at a particular location and time;
- innovate the existing technologies or equipment and select new production programs based on „ecological“ criteria;
- incorporate in the existing industrial and heating plants various new installations (collectors, electro-filters, etc.) which will prevent or at least reduce the emission of pollutants into the atmosphere;
- in transportation, use any engine-related technical improvements which could contribute to the reduction of the pollutant emission through the vehicle exhauston gases. In towns and industrial centers it is absolutely necessary to use high-octane unleaded gasoline;
- occasional stoppage of operation in industrial plants exceeding emission limit values (ELVs);
- select a process, within selected technologies, for the purpose of better hermetization;
- insist on planting as many trees as possible in urban areas (acacia, pine, abele) that would enable additional purification of air;
- connect green areas with the forestland, which could provide sufficient flow of fresh, healthy air masses from uninhabited areas
- expansion and sedimentation of pollutants in the air are determined by dynamic processes reoccurring in the atmosphere that are totally dependent on meteorological conditions.

Acid Rains

The term “acid rains”implies precipitation (as rain, snow, sleet, mist, fog and low clouds) containing pollutants. It was first used by Smit (1872). When acid substances get on the soil in form of deposit, it is called acid deposit.

The precipitation (wet deposits, rains) is often of slightly acid reaction due to the presence of carbonic acid (H_2CO_3) within, as a result of carbon dioxide's (CO_2) presence in the atmosphere. However, as the result of anthropogenic activities (mainly combustion of fossil fuels) air contains gaseous compounds – oxides of sulfur and nitrogen, that dissolve in water forming thus respective acids (first and foremost the sulfurous acid H_2SO_3 and nitrous acid HNO_2). The precipitations in urban and industrial zones, abundant with these acids, are designated as acid rains. Acid rains are those rains whose pH is below 5.6. This problem largely depends on the movement of air masses and has a global character. Critical annual deposition of nitrates ranges from 10 to 20 kg/ha while annual deposition of 2-5 kg/S per hectare is considered as critical. In some regions of the Netherlands, Belgium and Denmark, annual intake of pure nitrogen through precipitation amounts up to incredible 300 kg/ha.

The acid water deposits are extremely dangerous for the living organisms, especially plants, mosses, terrestrial organisms as well as aquatic ones (fish). Under the effects of acid rains, forest vegetation degrades, agricultural areas are destroyed (acidification of soil), and lakes sustain fish kill. A direct consequence of the soil acidification reflects in an increase of heavy metals accessible to plants, and subsequently their entry into the food chain. In the interest of consumers' health, soils must be protected, especially those that have been identified as quality and suitable for the most demanding productions. Additionally, the level of agro-ecosystem vulnerability must be valorized, and polluters must be requested to pay damages; in a broad sense, Europe must be given the bill for the previous exceeding of emission limit values. Any polluters must reduce their emissions or should be relocated from the area of production of biologically more valuable food. The increase of the height of stacks, even up to 1,000 m, for the purpose of reducing pollution, yielded no significant results but only contributed to the reduction of pollution locally, near the pollution source.

Apart from sulfur and nitrogen compounds, the atmosphere contains other salts and dust, hydrocarbons, etc., as aerosols (suspension of fine solid or liquid particles smaller than 0,001mm, therefore they are very light so that gravity practically has no effect on them).

Greenhouse Effect

The average annual temperature at the Earth's surface is around 15 °C. It is controlled by atmospheric gases that absorb the Sun's short-wave radiation and reflect it as infrared (thermal) radiation. Simultaneously, these gases redirect the reflecting infrared radiation from the Earth's surface back to the Earth's surface, causing thus this part of the atmosphere to heat up. This effect is called the greenhouse

effect, while gasses that cause it are called the greenhouse gases. Major greenhouse gases include water vapor (H_2O), carbon dioxide (CO_2), methane (CH_4), nitrogen suboxide (N_2O), nitrogen oxides (NO_x), tropospheric ozone (O_3), carbon monoxide (CO) and halocarbons (CFC chlorofluorocarbon). Temperature on Earth would have been lower by several Celsius degrees if those gases are not present (IPCC, 2001).

However, since the beginning of the industrial revolution to this day there has been an evident increase in the concentration of glasshouse gases in the atmosphere. The atmospheric concentration of CO_2 as a most significant glasshouse gas, increased from 280 ppm in 1750 to 367 ppm in 1999, which is a total growth of 31 %. The concentration of atmospheric methane (CH_4) since 1750 has increased by approximately 150 % (1,060 ppb – part per billion), while the concentration of nitrogen suboxide (N_2O) has continuously increased through the industrial era and now it is by 16 % (46 ppb) bigger than in 1750. It is believed that the man-induced increase in the concentration of glasshouse gases in atmosphere has caused the increase in the average temperature on the Earth better known as global warming.

There are natural and anthropogenic sources of glasshouse gases emission. Major natural sources of the above listed gases are terrestrial ecosystems: soil, plants and animals, wetlands and volcanic eruptions. The human activities significantly contributing to the increase in greenhouse gases are including combustion of fossil fuels, transportation, and conversion of forests into agricultural land. Forests, being the principle consumers of carbon-dioxide, have been reduced in the past 200 years by one third. The energy sector is responsible for two thirds of carbon-dioxide emission, about 1/3 of methane emission and around 85% of nitrogen oxides emission. The biggest contributors to the increase in the quantity of ground ozone are gasoline engines.

The longstanding goal of the international community is to stabilize atmospheric concentration of the glasshouse gases at a level which will prevent dangerous effects of human interventions in carbon cycle (J.P. Bruce, et al., 1998). By the end of the century, climate changes and their impacts may be the dominant direct factor (driver) of biodiversity loss and global changes in ecosystem functions. The scenarios developed by the Intergovernmental Panel on Climate Change (IPCC) project the increase in global mean air temperature by 2.0-6.4oC compared to the pre-industrial level until 2100, increased incidence of droughts and floods, and rise of the sea level by additional 8-88 cm between 1990 and 2100. Damages thus inflicted on biodiversity will be increased everywhere in the world.

On the other hand, some ecosystem functions in certain regions may initially show some improvement thanks to the forecast climate change (e.g. increase in temperature or precipitation) gaining in that way benefits at the lower levels of climate changes. However, becoming more pronounced and stronger with the climate changes, the harmful impacts on the functions of the ecosystem will prevail over the

beneficial ones in most regions of the world. The overall scientific evidence indicates that there would be a significant total damage to the functions of ecosystem if the global surface temperature raised by more than 2 °C compared to the pre-industrial level, i.e. if the rate of its growth was bigger than 0.2 °C per one decade.

The European Union's Climate and Renewable Energy (CARE) outlined the following package of targets the so-called „20 + 20 + 20 package“:

- To reduce emissions of greenhouse gases by 20 % by 2020
- To increase the share of renewable energy by 20 % by 2020
- To increase energy efficiency to save 20% energy by 2020

A success in achieving these targets will also reduce air pollution in Europe. For example, improved energy efficiency and increased share of renewable energy lead to the reduction of use of fossil fuels, which is the key issue of air pollution. This positive effect is considered as a *co-benefit* of the climate change policy (EEA Signals 2011).

Agriculture and Greenhouse Effect

The soil, i.e. soil organic matter, represents the largest component (1720 Gt C) of the carbon cycling from the atmosphere to the biosphere, and at the same time it is the habitat to the terrestrial photosynthetic organisms (plants), which annually fixate 110 Gt of carbon. (Sweeney and Grunwald, 2006).

As the largest terrestrial form of carbon, the soil organic matter plays a crucial role in its global cycle. The quantity and quality of soil organic matter is closely related to the parallel processes of its formation and decomposition that are in a dynamic balance characteristic for the given type of soil and status of environment. This balance is disturbed by the process of soil cultivation which accelerates mineralization of organic matter. It can be stated that the conversion of forest land into agricultural, frequent tillage as well as erosion of the top layer, have reduced the level of organic C in the soil by 50 % relative to its level in natural soils and simultaneously increased emission of CO₂ into the atmosphere. On the other hand, an increased level of organic matter in soil would help return a part of the lost C from the atmosphere and slow down the increasing trend of the greenhouse gases concentration in the atmosphere. Consequently, dynamics of C in the soil, i.e. methods for managing the soil play an important role in the climate regulation function of soil. The soil organic matter, that is 58% built by C, represents one of the major national resources (Lal, 2001).

It is estimated that the previous carbon losses from agricultural land amount to 78 ± 12 Gt C at global level, and that the major portion of this carbon has ended up in the atmosphere (Lal et al., 2004). Major sources of the greenhouse gases emissions from the plant production sector are as follows:

- mineralization of soil organic matter and emission of CO_2 due to tillage and other types of soil disturbances within agricultural activities,
- CO_2 emission due to soil erosion and erosion induced degradation of soil,
- natural levels of emissions of N_2O and NO_x from soil, and emission due to N fertilization,
- emission of methane from rice fields, wetlands and landfills.

The carbon losses from agricultural land were most intensive in the first decade of cultivation. Over time, the level of losses declined due to the reduced amount of available carbon for decomposition and gradual improvement of the soil management practices. Nowadays, most agricultural land is neutral in terms of CO_2 emission, which means that it neither acts as a source of anthropogenic CO_2 , emission nor the place for storing CO_2 from the atmosphere.

After the Kyoto Protocol on climate change, this topic suddenly began receiving public attention. The Kyoto Protocol implementation strategy includes reduction of the consumption of fossil fuels through improving the energy efficiency and developing renewable energy sources on one side, and identification of storage locations as well as the increase of carbon storing levels on the other. This has drawn attention to the necessity for designing new soil management practices that will support the storage of C in the soil.

Numerous studies on the carbon cycle developed in the past decade point out that terrestrial and aquatic ecosystems of the North Hemisphere absorb the atmospheric CO_2 at the rate of 3 Gt C year^{-1} (Fan et al., 1998). According to the publication released within the TIGER Program, 1999, soil and vegetation absorb around one quarter of extra carbon emitted by human activities, which poses a very efficient obstacle to climate changes.

In order to achieve a higher level of carbon storage in the soil, agricultural practice has to increase the supply of C to the soil in the form of plant detritus (increase of biomass net production) and decrease the level of decomposition of soil organic matter (conservation practice). The major processes of storing carbon in soil include: humification of organic matter, aggregation through the formation of organo-mineral complex, deep storage of organic matter below tillage level, cultivation of plants with deep root system, calcification.

An estimate shows that one half to two thirds of the total losses of carbon from agricultural land assessed so far, may be returned into the soil in 50 years, IPCC (2001) suggests potential growth of soil carbon of approximately 0,4–0,6 Gt C year⁻¹ (20–30 Gt cumulatively over 50 years), through better management of the existing agricultural soils. This way, the soil quality would be directly increased which would provide for the production of a large quantity of biomass (increased yields in agriculture and forestry) which also represents the absorbent of the atmospheric CO₂. The current estimate of the potential for mitigating the trend of increased concentration of atmospheric CO₂ by biological options is around 100 Gt C (cumulative) to 2050, which is equivalent to 10–20% of anticipated emission of CO₂ resulting from the combustion of fossil fuels in that period. However, huge reserves of C in the soil may imply a higher emission of CO₂ in the future in case that the practice of carbon conservation in the soil would be abandoned.

Depletion of Ozone Layer – Ozone Holes

By far the biggest portion of atmospheric oxygen is contained in the form of a stable two-atom molecule O₂. Under some special conditions, oxygen may form the unstable molecule O₃ composed of three oxygen atoms called *ozone*. The unstable ozone has a pronounced tendency to get rid of the additional oxygen atom which makes it a very aggressive and reactive oxidizing agent. Because of this property, its presence in the lower layers of atmosphere (troposphere) is not desirable. On the other hand, in the upper atmosphere layers ozone plays a key role in climate regulation and preservation of biosphere. It is exactly the stratosphere that major part of atmospheric ozone is concentrated in. At the altitude of 15-50 km, depending on geodetic latitude, there is an atmospheric layer in which ozone concentration is 10 times bigger than in any other ones. For this reason, this atmospheric layer is called the *ozone layer* or *ozonosphere* or *ozone shield*. Concentration of ozone in ozone layer is 10 ppm, whereas average concentration in overall atmosphere is 1 ppm. When the ozone concentration in ozone layer drastically deteriorates or else equates with the average concentration level, this occurrence is referred to as depletion of ozone layer or “*ozone hole*”.

The key role the ozonosphere plays in regulation of climate and preservation of biosphere is related to the absorption of the Sun’s ultraviolet light. Prior to entering the atmosphere, around 49% of the total energy of the Sun’s light belongs to the ultraviolet portion (*sunlight radiation* wavelengths range from 400 nm to 750 nm). At the Earth’s surface, the portion of ultraviolet (UV) radiation is reduced to 3% while the infrared one amounts to 55%, and visible part to approximately 42%. The principle filter and eliminator of the major portion of ultraviolet radiation is the stratospheric ozone.

The ecological effect of ultraviolet radiation has not been sufficiently examined yet. It is known that small doses are essential to many species, while high doses may be harmful. In humans, for example, normal ultraviolet radiation allows formation of anti-rickety vitamin D. In terms of physiology, vitamin D is very important as it regulates the exchange of calcium and phosphorus in the body, as well as ensures regular growth of bones and skeletal system in general in humans and other vertebrates. Yet, in humans a higher ultraviolet radiation may initially cause sunstroke, which is the first protective reaction of the skin, and ultimately skin cancer. Increased ultraviolet radiation has negative impact on immune system and vision, and most likely causes changes in genetic material. In plants, the increased ultraviolet radiation in the first place reduces the intensity of photosynthesis, while even bigger doses destroy plant cells.

It is estimated that the reduction of ozone concentration in the atmosphere by 1% leads to the increase of ultraviolet radiation on Earth by 2-3%, and quadruples the skin cancer risk in humans. The realistic threats induced by ozone crisis include primarily:

- higher vulnerability of man and his health,
- reduced yields in agriculture and tightening of the food situation around the world,
- destabilization of the aquatic ecosystems of seas and oceans with incalculable consequences for the climate (algae as oxygen producers) and feeding of the mankind (fishery),
- disturbance of climate conditions on the Earth due to changes in stratosphere.

Depletion of the ozone layer is wrongly referred to as ozone holes, because if the holes actually existed the entire life in biosphere would be destroyed. This occurrence is actually about a decrease of its concentration within the ozone layer. The largest depletion of the ozone layer was discovered in 1986 above the South Pole, Antarctic, which in 1989 extended all the way to the regions of southern Australia. Since then there has been a number of evidences of the reduction of areas of the ozone layer affected by depletion, which has to do with a particularly strict and limited use of Freon. The scientists have so far registered a total of 18 holes in the ozone layer that vary in size and shape, but due to the Earth's rotation, the area of irradiation is far bigger than the depletion zones themselves.

The fundamental international document addressing the issues of the ozone layer protection is the Vienna Convention for the Protection of the Ozone Layer (1985). According to the provisions of the Vienna Convention for the Protection of the Ozone Layer (Vienna, 1985) the ozone layer is defined as „*a layer of ozone in the atmosphere above the planetary boundary layer*“. The same international document defines what is considered to be the harmful effects related to the ozone layer: „*changes in the physical environment or biosphere, including climate change, which have a harmful effect on human health that is – composition, adjustability and productivity of natural as well as artificial ecosystems, or materials beneficial for the mankind*“. The signatory parties to this Convention are obliged to, pursuant to their available resources and abilities, cooperate in regard of control, limitation, reduction or prevention of the activities under their jurisdiction, if they are determined to may have or have had harmful effects on the ozone layer. In addition, the countries are obliged to cooperate in regard of collecting, controlling and submitting data obtained by researches and monitoring of the practices, as well as in legal, scientific and academic areas.

In the effort of developing a more comprehensive strategy for the protection of the ozone layer, in 1987 the Montreal Protocol on substances that deplete the ozone layer was adopted. It actually operationalized the measures and responsibilities foreseen by the Vienna Convention for the protection of the ozone layer. It identifies all major substances that deplete the ozone layer and determines specific limitations with regard to the levels of their production and consumption in the future. There are two groups of substances that deplete the ozone layer: group I – chlorofluorocarbons (CFC- 11 and 12, CFC- 113-115) and group II – halons. The Montréal Protocol is periodically innovated and updated through the adoption of amendments and in accordance with new information acquired thanks to the scientific and technological progress. The Protocol had initially designated year 1996 as the ultimate deadline for gradual discarding of chemicals that deplete the ozone layer. This convention was ratified by former Socialist Federal Republic of Yugoslavia in 1990.

The impact of agriculture on depletion of the ozone layer is reflected through an increased emission of nitrogen oxides from the soil, which is a consequence of the application of nitrogen fertilizers, as well as protection chemicals containing methyl bromide (largely used in production of tobacco seedlings).

WATER POLLUTION

The structure and functioning of the aquatic ecosystems changed in the second half of the twentieth century much faster than in any other periods of human history. A total quantity of water locked behind dams has quadrupled since 1960 to this day, and amount of water kept in reservoirs is three to six times bigger than in natural rivers. The Millennium Assessment provides disturbing information that the consumption of fresh water reserves and net fishing in the seas currently exceed the level of sustainability, even at this level of market demand, let alone the future one. The consumption of fresh water at the global level exceeds available reserves by 5% - 25%. The difference between available and required fresh water is compensated either by artificial transfer of water or excessive exploitation of surface waters. Likewise, at least one quarter of commercially significant fish supply comes from overfishing, which is amazing information indicating a serious vulnerability of the maritime environment. Another harsh ecological issue the world is currently facing-pertains to water pollution and availability of water in arid areas.

In nature, water is rarely found in totally pure state. During the process of its natural cycling, many gases, mineral and radioactive matters, microorganisms, etc., get into it. The pollution of water may occur naturally, however, it is usually caused by human activities – chemical, biological or physical. Water pollution can also occur in a natural way by the introduction of various products of decomposition of flora and fauna detritus, as well as under the influence of runoff.

Most responsible for the pollution of natural water resources are the world largest water consumers that participate in the anthropogenic cycle: industry, agriculture and population. The levels and structure of pollution largely depend on the ways these activities occur within the cycle (applied technology and life style), as well as on the number of inhabitants in a given area who perform these processes.

Rapid industrial development and growth of the population in urban centers have particularly contributed to the pollution of rivers, lakes and seas by discharging industrial and municipal waste waters. The waste waters contain pharmaceutical preparations, detergents, oil, petroleum, metals and other materials harmful to flora and fauna. Synthetic chemical compounds from waste waters may also get into drinking water.

According to data from the UN's statistics, around 6 million tons of various waste materials are thrown into streams, rivers and lakes every day.

Microbiological pollution/contamination of water is usually caused by discharge of untreated sewage waters, and level of contamination is controlled through occasional testing for microorganisms -bacteria *Escherichia coli* which are found in human intestine.

The heat released in the process of cooling of the electric power production plants is also one of the pollutants causing a disturbance in the aquatic ecosystems by inducing excessive growth and abundance of plants and animals.

Pollution/contamination of groundwater, the world's largest reservoirs of fresh water, is usually caused by atmospheric precipitation, which percolates through the landfills of solid waste materials (disorderly and „wild dumps“), or through agricultural land on which chemical such as mineral fertilizers and pesticides were improperly applied. One of the biggest challenges of the modern world is contamination of water reservoirs with pesticides and mineral fertilizers that infiltrate the water reservoirs by surface and subsurface runoff from agricultural land. This is the biggest threat to fulfilling the requirements for fresh water in the future. Under the conditions of the ever growing agricultural production, waters are polluted by: nitrates, nitrites, phosphates, pesticides, heavy metals and polycyclic aromatic hydrocarbons. It is estimated that in the EU zone as much as 20 % drinking water contain residues of chemical substances used in agriculture in the amounts that exceed permissible limits. Leaching of nitrates and nitrites that infiltrate soil through mineral fertilizers and manure, as well as acid rains is a particularly pronounced concern. This is for example a huge problem in the Netherlands, with large livestock resources and high doses of fertilizers applied on the soil. Denmark, by many considered the country with the most developed animal farming in the world, has polluted its drinking water to the extent where it is forced to import it from Island. For this reason, many developed countries have introduced the so-called quota regime in use of mineral fertilizers. This way, permissible quantities of mineral fertilizers per hectare are determined for each individual farm, with special emphasis on controlled application of nitrate fertilizers.

The situation with phosphorus is somewhat different due its low mobility in the soil. However, the application of phosphorus rich fertilizers in light soils (porous permeable soils with smaller content of clay fractions) and excessive doses may cause pollution of ground waters. Additionally, erosion of the top soil particles and their infiltration into the watercourses may cause their contamination with phosphorus.

In rural settlements pollution of water may be caused by waste materials from agricultural production. This primarily refers to improper storage and management of barnyard manure and waste, previously untreated, and waters from the local *economic* facilities, such as poultry farms or large cattle farms. Within the „Nitrate Directive“ (Directive by the Council of 12 December 1991, for the protection of water from pollutions caused by nitrates of agricultural origin), the EU has strictly stipulated methods for storing (mandatory construction of effluent basins, etc.) and managing manure, in order to reduce its negative impact on the environment. Particularly threatening to the environment are the organic liquid N-fertilizers (manure, slurry), especially when applied on soil with no vegetation, frozen soil or soil in humid areas. Attention should be paid to the landfills for an organic and mineral fertilizer

exposed to the atmospheric influences, in which leachate easily gets into contact with well or ground water. The septic tanks that are not built in compliance with sanitary requirements pose a huge problem in rural settlements. Also, the waste waters coming from households that may contain excessive amounts of detergents, various organic matters and the like are directly discharged into small watercourses. Since groundwater is fed by such watercourses, its quality is directly dependent on the quality of water in the watercourses.

Eutrophication of Water

Eutrophication of water (Greek *eutrophos*: *eu* - good, *trophe* - food) is a process of enriching water with nutrients that support growth of aquatic plants such as planktonic algae and ocean floor algae, and higher aquatic plants. Accumulation of nutrients in water reservoirs accelerates growth of such plants, which burn most of the available oxygen at the expense of other water organisms. As a result, this process causes a reduction of biodiversity in such aquatic ecosystems as well as their clouding. Most common causes of eutrophication are the untreated sewage waste discharged into the water and application of nitrogen fertilizers in agriculture.

The aquatic organisms require two nutrients – nitrogen and phosphorus. Their shortage in the water brings microorganisms into a „struggle for life“. On the other hand, should the concentration of nitrate in water enormously increase, the population of eutrophic organisms would suddenly increase. At the same time, enormous amount of oxygen dissolved in water is consumed by them. Very soon after there is a shortage of oxygen necessary for the survival of fish and other aquatic organisms, which may lead to their mass killing and sedimentation of powerful organic detritus on the floor.

The pollution and eutrophication of waters are often a direct effect of incompetent management of chemical substances in agriculture. Namely, one of the most common forms of nitrogen used in mineral fertilizers is nitrate NO_3^- (there is also ammonium NH_4^+). Unlike ammonium which bonds with soil adsorption complex, primarily with clay minerals, thus preventing leaching, its nitrate form is usually found in soil solution available for uptake by plants. However, in case that doses of nitrate are such that plants cannot use it, it gets leached into the ground waters (from where it can infiltrate other water reservoirs) or by sub-surface outflows into open water surfaces. This way the improper application of nitrogen rich fertilizers leads to eutrophication of water bodies. For this reason, application of mineral fertilizers must be adjusted to the type and vegetation cycle of plants; soil properties (depth, texture, content of humus, existing content of nitrogen); as well as control of the basic fertility elements.



Picture 8. Pollution of watercourses (eutrophication)

Once the critical level of filling the aquatic ecosystems with nutrients, abrupt and intensive changes may occur in fresh water and coastal maritime ecosystems, and may lead to the blooming of algae (to include the toxic species), sometimes even to the formation of zones completely without oxygen, i.e. killing of most of the animals.

The occurrence of harmful as well as toxic blooming of algae in coastal waters shows an increasing trend, both in term of frequency and intensity, and they have detrimental impact on other sea resources, such as fishery, as well as on human health. In one such extremely large outburst that happened in Italy in 1989, in the Adriatic sea at the Po's delta, the algae blooming cost the coastal aqua-economic industry 10 million \$, and Italian tourism 11,4 million \$. (Millennium Ecosystem Assessment)



Picture 9. Blooming of algae

Availability of Drinking Water in Arid/Dry Areas

Lack of spring water, as well as growth of the population and increased consumption of water, has led to an increased resorting to surface waters (rivers, lakes) for human needs. Water tapping from rivers and lakes has doubled since 1960, where most of this water is used in agriculture (about 70%).

Areas suffering from a frequent lack of water are called arid. The arid systems cover around 41% of the total land areas on the planet, and are home to more than 2 billion people, out of which more than 90% in developing countries. The arid ecosystems (that comprise both rural and urban arid areas) experienced the highest population growth rate during the nineties in the past century, higher than any other ecosystem included into the Millennium Assessment.

Although the arid areas are home to approximately one third of the world population, they have only 8% of the world's total amount of renewable water resources. Considering the low precipitation and their volatility, high temperatures, low level of soil organic matter, high cost of electric power supply or water supply through the waterworks, limited investments in infrastructure due to low popu-

lation density, and the population inhabiting arid areas are faced with numerous challenges. They also show a deteriorating trend towards the lowest level of human wellbeing, to include the lowest gross domestic product (GDP) per capita, as well as the highest infant mortality rate.

With regard to the number of people who have no access to clean drinking water, the most severe situation is in Africa where 50% population is supplied with water of poor quality. When speaking about development perspectives of these areas, it can be stated that they are particularly dependent on measures/activities undertaken in order to avoid or slow down the process of degradation of ecosystems, and return to the previous state once degradation had already occurred.

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The issue of environmental protection is not only a concern of local (national) legislation but of international too. The existing links or the links yet to be established between the local and international legislative are a result of the pollution hazards that „do not recognize“ state borders, since an environment cannot be protected partially, only by consolidating all international subjects.

Precisely because of its international character, ecological issues became the focal point of interest at international and global levels. Issues related to this problem are being considered very closely within the UN and other international institutions, which in turn resulted in numerous conferences and assemblies adopting various declarations, conventions, charters, protocols, strategies, information on environmental protection, etc. The listed documents ensure international and legal protection of the environment which can only be accomplished by proper cooperation of national and international institutions leading to the launching of actions to resolve successfully ecological problems.

Chronologically speaking, the first references to humans' right to live in a healthy environment can be found in the Hammurabi Code of Laws (ruler in ancient Babylon, 1792 BC – 1750 BC), Old Testament, Roman Regulation on Construction

of Aqueducts etc. Legal disputes in the history of English Law from the 17th century (trespass, neighborhood disturbance etc.) contain small portions of environmental issues and represent a continuity of legal tendencies in that regard. In the 18th century the Judicial System of Great Britain dealt with the disputes concerning *excessive production* of smoke. Industrial revolution took place in the 19th century, however it included regulation on smoke emission, water pollution, trespassing, sanitary treatment of waste and trash, hygiene, housing etc. Only in the 20th century the environmental protection became a global problem that could not be resolved by individual countries, so many international conferences were held resulting with the adoption of numerous documents concerning protection and improvement of the environment.

According to the Register of International Treaties and Other Agreements in the Field of the Environment (designed by the Secretariat of the United Nations Environment Program - UNEP), many multilateral agreements that are fully or partly related to the environment were concluded until 1977. Among all the conventions, agreements, contracts enacted until 1977, the most important one is the United Nations Conference on the Human Environment from 1972. The convening of this Conference was initiated by the Club of Rome.

CLUB OF ROME AND ENVIRONMENTAL ISSUES

An important consideration of the environmental problems has emerged from the Club of Rome activities, which are featured in its reports. The Club of Rome was established by Aurelio Peccei, the Vice President of FIAT in April 1968, by convening a conference of economists, geneticists, political scientists, sociologists, managers, and managers of research institutions to discuss environmental issues. The founder of the Conference was convinced that environmental problems common to the modern world can be solved only by joint action of all nations. The Club of Rome was founded at the Conference, and its mission was to explore the state of the environment by using exactly defined methods and proposing the most rational strategy to solve environmental problems. Two conclusions were adopted at the first inaugural meeting of the Club:

- First, it was concluded that the rate of population growth, the use of natural resources and environmental changes indicate a fast (maybe 25 years) exhaustion of natural resources, which will halt the progress and cause social conflicts, political struggles and human misery,

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- Second, it was concluded that in contemporary society, these problems globally and explicitly are not being seriously considered. In that regard, the Club decided to hire the world's famous experts for investigation of the global environmental problems and presentation of the results to the general public. For that reason, the Club hired a group of scientists from the Massachusetts Institute of Technology.

The **First report** for the Club of Rome was prepared by scientists at the Massachusetts Institute of Technology headed by Denis Meadows. This report was published in a book titled *The Limits to Growth* (1972). The authors of the report created a world model with regard to five main research directions: a) dealing with global issues of rapid industrialization, b) rapid population growth, c) world's widespread malnutrition, d) exhaustion of nonrenewable natural resources, and e) violations of the environment. These are the trends they suggest, in many ways interdependent, and their development is measured in decades or centuries rather than months or years. The authors of report emphasize their interdependence and their implications in the next hundred years.

Conclusions made by this group of scientists are summarized as follows:

- First, if the current growth of the world population, industrialization, food production and depletion of natural resources continue with no changes, the limits of growth on Earth will be reached in the next hundred years.
- Second, it is possible to alter these growth trends and to establish a condition of ecological and economic stability that is sustainable far into the future. The state of global equilibrium could be designed so that the basic material needs of each person on earth are satisfied and each person has an equal opportunity to realize his individual human potential.
- Third, if the world's people decide to strive for this second outcome rather than the first, the sooner they begin working to attain it, the greater will be their chances of success.

In fact, this report indicated that the exponential growth leads, in any case, to the exhaustion of all available reserves.

The report entitled *The Limits to Growth* has been widely accepted throughout the world, but, it was also criticized for analyses and measures proposed to be taken to avoid catastrophic consequences. The authors of the report were criticized with regard to the use of partial information, unsubstantiated data on stocks of raw materials, for underestimating the impact of technological development in agriculture

and the possibility of increasing food production. Also they were told that the report lacked deeper values and value changes in social development. But the harshest criticism was directed to the requirements of limiting the economic and population growth. This critique points out that the fatal weakness of the model contained in the study is a proposal to “*stop the economic growth worldwide, which would keep and maintain the current gap between developed and developing countries and destroy hope of hundreds of millions of people who want to be saved from the misery they live in*”.

Two years after the first report of the Club of Rome, which was the subject of both praise and criticism, the second report appeared *Mankind at the Turning Point* (1974). The **second report** is less pessimistic than the first one. And yet, it does not mean that it was or could be accepted in all its parts. The authors of this report did not take into account various proprietary relations existing in modern world in certain countries, which have the sovereignty in terms of decision making, to include decisions pertaining to development.

The authors attempted to answer these questions and alleviate the pessimistic message of the first report. In fact, the authors of the *Mankind at the Turning Point* sought to answer five questions. These questions, as they formulated them, are as follows:

- Crises related to energy, food, raw materials, etc... are they constant or a product of our misunderstanding and negligence?
- Can the crisis be solved within national, regional or local boundaries or permanent solutions should be sought world-wide?
- Can the crisis be solved by using traditional measures (which were restricted to specific aspects of social development, such as technology, economics, politics, etc. ...) or the strategy should be comprehensive and included in all aspects of social life?
- Should the effort of finding solution to the crisis be urgent? Will delaying those efforts make the solution easier or more difficult? Is there a way to solve total crisis with open cooperation avoiding unjustified sacrifices by any participant? Is there a possibility to find a solution which would make a profit worldwide?

In seeking “a new mankind on the path of organic growth,” according to the writers of the report, a “**new global ethic**” is established that will require changes in human behavior. The changes in the behavior of every individual are listed as:

- First, It must become a part of the consciousness of every individual that “the basic unit of human cooperation and hence survival is moving from the national to the global level”.

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- Second, a new ethic in the use of material resources must be developed, which will result in a style of life compatible with the oncoming age of scarcity.
- Third, an attitude toward nature must be developed based on harmony rather than conquest (Only this way man can apply in practice what is already accepted in theory - meaning that man is an integral part of nature).
- Fourth, if the human species is to survive, man must develop a sense of identification with future generations.

To accomplish these changes in individual's behavior and to develop *new world's ethic*, the writers of the report emphasized the requirement of developing a new form of education that will be modified and appropriate not to the 20th but to the 21st century.

The **Third Report** of the Club of Rome is entitled *RIO - Reshaping the International Order*. The report contains a critical analysis of the world economic system. The main problem of the contemporary world is in uneven distribution of power and wealth and existing gap between rich and poor nations, rather than physical boundaries. The fundamental question to which this model attempts to answer is how long it should take such a society to meet the basic needs of every individual in food, basic education and housing. Answers they provide read as follows: In developed countries, this could happen in several years, in Latin America in early 1990s, and in Africa around 2008. In Asia, however, after a brief progress there will be a stagnation, and then after 2020, a rapid decline and catastrophic starvation. The only way out, according to the authors, is international solidarity. Starting from 1980, the industrialized countries were supposed to allocate 2-4% of their national income for Africa and Asia, as long as these two areas become capable of fulfilling the basic needs of their populations.

The first three reports indicated a risk from ecological catastrophe to the mankind, which resulted in hopelessness, and the spreading of pessimistic sentiment among the people. So, there was a need to provide an optimistic outlook on the future of humanity.

The **Fourth** report by the Club of Rome was provided in the book *Goals for Mankind*, which analyses the world through the prism of political and economic settlement, influence of multinational companies, religions and international organizations. As the common interests of the nations, though they are often politically and military conflicting, the report stated the goals of global security, provision of food and conservation of energy and natural resources.

The first global goal of the human community, according to the author of this report, is the preservation of peace as a precondition for its safety. Another interest is to ensure food for entire humanity. The third global goal of the human community is related to energy and natural resources. The report indicates "*the wasteful and inefficient forms of energy must be reduced in order to gain time to develop those types of energy that are sufficient to meet human needs far into the future*".

In fact, the report shows that energy issues should be viewed not only economically, but also from the sociological point of view, precisely - the socio-ecological. In this report, an approach to environmental problems was criticized too. In fact, it was emphasized that the consideration of environmental problems in the *Goals for Mankind*, started from the (former) economic and political division of the world and division of countries into developed and underdeveloped. The critics were also aimed at reducing the problems of modern civilization to just the problems related to food, energy, and resources while neglecting the problem of pollution and environmental consequences of the increased birth rates in developing countries.

The Book entitled *Beyond the Age of Waste*, published in 1978, is considered as the fifth report by the Club of Rome. The researchers sought to determine the role and possibilities of science and technology in solving the problem of scarcity of food, materials and energy. In so doing, they indicated that all materials have alternative replacements - substrata, but with no adequate method to produce enough energy that would be economically acceptable.

The optimistic views to the possibility of solving the ecological crisis are increasingly mentioned in other scientific studies. In that regard, for example, Herman Kahn in his book *The Next 200 Years* presents a world view in the next two hundred years (1976 - 2176). He thinks that in this period many problems that have arisen from rapid industrialization may be resolved and conditions for a balanced and rapid progress of mankind be restored. In his view, these conditions will be created based on resources available on the Earth and by exploiting the outer space. Thus, for example, to increase the world's production capacities by 60-fold it is necessary to increase the power consumption by 15-fold. And this increase in energy can be easily achieved in the framework of known solutions, as well as the solutions that can be expected (nuclear fission, solar geothermal energy use).

In addition to the reports to the Club of Rome, which contents are presented in a nut shell, there were also some other reports prepared by the Club of Rome related to environmental problems, i.e. environmental protection. Thus, between the third and the fourth reports there were other two attempts at global approach to addressing and resolving problems of the mankind. One of them is a study of the Japanese section of the Club of Rome, which was published under the title *New Development Vision*. The second one was the study of a South American group, entitled *Catastrophe or a New Society*.

THE STOCKHOLM CONFERENCE – THE FIRST CONFERENCE OF THE UNITED NATIONS

The United Nations Conference held in Stockholm (5-16 June 1972) was dedicated to environmental protection and is considered to be the turning point in coordinating international actions at the largest scale possible with adopted principles for international regulation of these subjects. The Stockholm conference is significant since it supported the belief that the problem of environmental pollution can be solved only by a concurrent resolution of economic and social problems of the modern world, hence it can be accomplished only through a well-coordinated international cooperation and simultaneous problem solving by improving the living standard of all people in the world. The environmental protection, according to the Declaration, is the imperative goal of the mankind since the Earth's resources must be preserved not only for the current, but for future generations as well. The Declaration of the Conference states the following:

- Man is both a creature and molder of his environment, which gives him physical sustenance and affords him the opportunity for intellectual, moral, social and spiritual growth. In the long and tortuous evolution of the human race on this planet a stage has been reached when, through the rapid acceleration of science and technology, man has acquired the power to transform his environment in countless ways and on an unprecedented scale. Both aspects of environment, the natural and the man-made, are essential to his well-being and to the enjoyment of basic human rights - the right to life itself.
- The protection and improvement of the human environment is a major issue which affects the well-being of peoples and economic development throughout the world; it is the urgent desire of the peoples of the whole world and the duty of all Governments.

At the Conference in Stockholm, the doctrine of unlimited territorial sovereignty, by which the state on its territory may be in dispose of goods and assets, regardless of the fact that such actions may be harmful for the other side (also a sovereign state), is replaced by new views and attitudes that limit that "right". The idea of absolute sovereignty of the state is losing their supporters, since the prevailing view is that the states are obliged to make sure that their actions do not harm or do not impair the rights of other states. It was crucial to creating a foundation for international legal system for environment protection.

International framework is created under the auspices of the UN, which enables a wide range of cooperation and exchange of experiences in all aspects of en-

vironment protection and its legal regulation. The UN Environment Program (UNEP) plays an important role in all UN actions. After Stockholm, many states confirmed the right to a “healthy” environment, its protection, preservation and improvement, by raising it to the constitutional level.

Developed countries and a large number of developing countries were giving the environmental issues a high priority in the period between the Stockholm and the Rio Declaration (1992). They were coordinating their policies in this area and harmonizing measures and activities, particularly on the issues of global significance (air, ozone cover, forests, biodiversity, transboundary pollution, protection of water and the sea, air protection, etc.).

RIO DECLARATION – THE SECOND UN CONFERENCE

Globally, the new strategy of environmental protection is being established and reinforced. It was confirmed at the United Nations Conference on Environment and Development (UNCED), held in Rio de Janeiro in June 1992.

Rio Declaration has set the foundation for addressing the environmental issues as inseparable part of development and provided a new impulse to the process of creating the broadest forms of cooperation between developed and developing countries. Environmental interests were polarized around regional groups:

- Developing countries and China,
- European Union,
- Nordic countries,
- Central and Eastern Europe countries.

It was concluded that poverty is the most serious form of degradation of the environment and that global environmental problems cannot be solved if the poverty, which is still present in two-thirds of the world population, is not eliminated and if they do not establish a new partnership between developed and developing countries and promote funding mechanisms. The Rio Declaration proclaims 27 principles considered to be the basic principles of modern politics and environmental law, international relations with regard to environmental problems. The most important principle adopted by the Conference is the commitment made by the signing parties to achieve a *sustainable development* based on the principle of envi-

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ronmental protection as an integral part of the development and establishment of the obligations where polluter pays the cost of damage and impact of his activities on the environment. Sustainable development means: *“achieving economic growth in accordance with the terms and capacities of the environment, which will enable the development of future generations”*.

When it comes to ecological principles of environmental protection and development, this should be taken as a moral support and confirmation of the international community about really poor condition of the environment. However, material investments in the recovery of endangered environment and prevention of its further degradation will depend on readiness of each country to implement legislation and economic policy measures to ensure the implementation of this concept. Among the adopted documents were:

- Rio Declaration on Environment and Development,
- Convention on Climate Change,
- Convention on Biodiversity,
- Principles of Forest Management, Protection and Sustainable Development,
- Agenda 21 – Program of activities for the 21st century.

When it comes to air or water pollution, the standards on maximum level (ML) of pollutants were defined; however the installation of appropriate equipment and its normal functioning is problematic. The reason behind it is ineffective rule of law and lack of institutions at the state level at this time.

Somewhat different responsibilities were proposed by the Convention on Biological Diversity for the preservation of biodiversity, including the overall measure of *sustainable use of biodiversity* and specific national measures to protect valuable biological resources, or certain components of biodiversity. The term biodiversity implies biological diversity of living organisms on Earth, or in a specified area, including diversity within species, between species and of ecosystems. The Convention emphasizes the importance of universal values of the biosphere. However, the reduction of biodiversity protection to *sustainable use* cannot preserve its general values, since degradation of ecosystems and the destruction of certain species, impoverishes and reduces biodiversity under the influence of “sustainable development”. Therefore, the Convention foresees that important components of biodiversity, including particularly valuable landscapes, ecosystems, or elements (gene pool), or rare species and their habitats, should be retained and improved using special measures for legal protection of nature. It was established in our regulations on environment protection and biodiversity.

Agenda 21 is a guideline for the application and implementation of sustainable development in all sectors of development and use of the environment in the 21st century. All participating countries have committed themselves to implement the Agenda 21 and to form their own Commission on Sustainable Development. As developed countries based their development on the consumption of planetary resources, causing the environment contamination, they also accepted the obligation to allocate 0.7% of their national income to help the underdeveloped and developing countries to overcome the problem of pollution and to help them with new technologies.

EARTH SUMMIT +5

The main objective of the UN Conference *Earth Summit +5*, held in New York (1997), was to analyze, using the reports of all countries, how much has been achieved since the last UN Conference on Environment and Development held in Rio de Janeiro in 1992, as well as the implementation of Agenda 21. The Agenda 21 was the essence of the reports of all countries.

After having submitted their reports, more than 50 statesmen, 150 state ministers, as well as directors and representatives of major international organizations (UNEP, FAO, IMF, UNESCO and others), and after having several Conferences held within the UN Commission on Sustainable Development, the general conclusion of the Summit was that only a few things were accomplished of what was agreed at the Rio Summit in 1992, despite the progress shown. The focus was particularly on climate change, poverty, the threat to biodiversity, deforestation, and accumulation of hazardous and other waste materials in all forms, increasing the need for hygienic drinking water. A main concern was expressed in two areas:

1. With regard to climate change, global average temperature increase (with the assumption of 3-5°C until 2010), potential melting of glaciers, which will lead to the rise of the sea level by 1m. This would submerge many island countries while others would suffer drastic changes, to include the rise of groundwater levels. In this way, problems would arise, both in urban and other settlements to include vegetation since ground water table would reach the root system of plants.
2. Drastic reduction of global forest resources, at reduction rate of 11 million ha / year. In order to protect the world's forests fund, it was proposed to adopt the Convention on Forests.

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Considerations, agreements, discussions and conclusions of the above two areas are as follows:

1. Since an increase in global temperatures is due to induced greenhouse effect (atmospheric accumulation in the form of large gas clouds), caused by emissions of carbon dioxide and nitrogen oxides, the decision was made for all countries to commit to reduce emissions of these gases by 15 % compared to 1990. Environmental pollution and other global issues have created an uncertainty about the survival of the planet in the 21st century. Since Convention on Climate Change was adopted in Rio and with several international meetings in relation to this problem, it was decided that the new United Nations Conference on this subject alone, is going to take place in December 1997 in Kyoto (Japan).
2. There was a long debate regarding the permanent reduction of the forests. Forests are important for climate (apart from the other many functions they have), oxygen production and carbon dioxide absorption. At the UN Conference on Sustainable Development, held concurrently with the General Assembly, it was proposed to adopt the Convention on the Protection of Forests. Namely, in 1992 in Rio de Janeiro a non-binding document on Forests was adopted.

Most countries, including the European Union countries and Russia, whose forest cover make up 1/5 of the world's resources, voted in favor of the convention. However, there was no consensus since the countries which are the largest exporters or importers wood voted against the Convention. These are: Brazil and other Latin American countries, USA, Australia and Canada.

On the other hand, it was emphasized that the U.S. is the largest air polluter producing 20% of the world's gas emissions that induce the greenhouse effect. However, America did not do much on the implementation of the Agenda 21, nor it pledged to reduce greenhouse gas emissions; it also neglected the obligation to provide financial support to the Agenda.

KYOTO PROTOCOL

The Kyoto Protocol was adopted in Japanese city Kyoto in 1997, as a protocol attached to the Convention on Climate Changes. Its goal was for the governments around the world to reach an agreement regarding emissions of carbon dioxide and other greenhouse gases (carbon dioxide, methane, nitrous oxide, hydro fluorocarbons, per fluorocarbons, and sulfur hexa fluoride). The Kyoto Protocol called on the

industrialized nations to reduce their national emissions during the period 2008-2012 by 5 percent below the 1990 levels.

An agreement was reached to reduce the gas emissions in the amounts proportional to pollution levels. In this regard, national limitations range from 8% reduction for the European Union and others, to 7% for the US, 6% for Japan and Canada etc. Some of the countries were permitted to increase their emissions (Australia, Iceland, Norway), while others were obliged to maintain their current levels (Russia, New Zealand, Ukraine). Currently, the biggest issue in this regard is reluctance of the USA to implement their commitments.

EU AGRICULTURAL LEGISLATION

The EU legislation on agriculture is particularly complex and voluminous (40% of total EU *acquis communautaire*). The harmonization efforts will require a specialized ministry at the state level to coordinate the work of harmonizing the legislation in this sector and to meet the requirements of EU and WTO.

Within the European integration processes, Bosnia and Herzegovina has to comply with 151 regulations and 190 directives, to include 85 regulations and directives pertaining to the food security. Given its complex internal administrative structure, in Bosnia and Herzegovina there are internal differences in the legislation at certain levels as well. It is necessary to harmonize legislation between various levels in Bosnia and Herzegovina, and to create legislation at the state level. This is important from the aspect of future harmonization of legislation with European Union requirements in the process of EU accession.

The reform of agricultural legislation in Bosnia and Herzegovina is being delayed due to the lack of adequate institutional framework and appropriate ministry at the state level, which would generate the state laws and supporting regulations for the agricultural sector, as well as take responsibility for the reform and harmonization with EU legislation.

In Bosnia and Herzegovina it is necessary to upgrade the existing and new legislation and adopt other agriculture related state level regulations such as: Law on Organic Farming, Law on Agricultural Land, Law on Incentives in Agriculture, Law on Agricultural Inspection, Law on Beekeeping, and many other laws and bylaws.

EU DIRECTIVES

EU Directives are the primary source for the harmonization of national laws and are binding with regard to the objectives to be achieved. They cannot supersede national laws, but national legislation is harmonized with EU regulations. Legal acts are published in the Official Journal of the EU, a document consisting of two related series (series L - legislation and Series C- information and notes) and enclosure (S - Public Procurement). The text of any secondary EU legal act contains information about the institution which adopted the act (EC, Council, EP), adoption date, type (regulation, directive or decision) and the number of EU legal act (CELEX number: for regulations and directives year/number, and for decisions and recommendations number/year). A European Union document consists of *the reference number of the document, title, bibliographic reference* (in most cases it is the Official Journal of the European Union <http://eur-lex.europa.eu/JOIndex.do>) and the *number of amendment*.

European Directives replace national regulations and set new rules for those who distribute products throughout Europe. The directives allow easy verification of product safety, by setting the basic requirements for health and safety of consumers. When a product complies with the Directive, then it must be marked with CE. The application of standards and legislation in the field of quality assurance, healthy and safe food for consumers and environmental protection are prerequisites for establishing a comprehensive quality system.

International quality management system ISO 9001 is compatible with ISO 14001 environmental management system and international OHSAS 18001 system (*Occupational Health and Safety Assessment Series*) while implementation of these related business systems incorporates the concept of "SHE" (Security, Health and the Environment).

Quality is one of the main prerequisites to export certain products to EU countries. Before the product is being marketed, the manufacturer must conduct the *assessment of compliance* with relevant technical regulations applicable in the field of security. All countries with aspirations to export their products to the single European market must adapt to the new requirements their products must meet. In the process of EU accession, Bosnia and Herzegovina will have to take over some of the technical regulations related to agricultural products.

RELEVANT EU REGULATIONS

Regulations are acts whose publication is obligatory. The most important EU regulations relating to the agricultural sector include:

Council Regulation (EC) No 1290/2005 of 21 June 2005 – This Regulation pertains to the functioning of CAP, and defines the establishment of two new funds: the European Agricultural Guarantee Fund (EAGF) used to fund market measures, and the European Agricultural Fund for Rural Development (EAFRD) intended to fund the rural development programs.

Council Regulation (EC) No 1698/2005 of 20 September 2005 – on support for rural development by the European Agricultural Fund for Rural Development (EAFRD). In order to ensure sustainable development of rural areas, the support should be focused on a limited number of core objectives at Community level related to agricultural production, economic competitiveness, land management and environmental protection, quality of life and diversification of activities in these areas, while respecting the diversity of relationships ranging from remote geographically and developmentally disadvantaged rural areas to suburban areas that are under the pressure of urban centers (cities, megapolis, etc.)

Commission Regulation (EC) No 883/2006 of 21 June 2006 – laying down detailed rules for the application of the Council Regulation (EC) No 1290/2005 regarding the keeping of accounts by the paying agencies, declarations of expenditure and revenue and the conditions for reimbursing expenditure under the European Agricultural Guarantee Fund (EAGF) and the European Agricultural Fund for Rural Development (EAFRD)

Commission Regulation (EC) 885/2006 of 21 June 2006 – laying down detailed rules for the application of Council Regulation (EC) No 1290/2005 as regards the accreditation of paying agencies and other bodies and the clearance of the accounts of the European Agricultural Guarantee Fund (EAGF) and of the European Agricultural Fund for Rural Development (EAFRD).

REGULATORY FRAMEWORK FOR ENVIRONMENT PROTECTION AT ALL LEVELS

The list of other EU legal acts, directives, regulations, conventions and other documents significant for the sector of environment is as follows:

.....
Council Regulation of 24 June 1991 on organic production of agricultural products and indications referring thereto on agricultural products and foodstuffs- 2092/91/EEC.
.....

.....
Council Regulation of 19 July 1999 supplementing Regulation No 2092/91 on organic production of agricultural products and indications referring thereto on agricultural products and foodstuffs to include livestock production - 1804/1999/EEC.
.....

.....
Council Regulation on support for rural development from the European Agricultural Guidance and Guarantee Fund (EAGGF) by reason of the accession of the Czech Republic, Estonia, Cyprus, Latvia, Lithuania, Hungary, Malta, Poland, Slovenia and Slovakia to the European Union - 1257/1999/EEC.
.....

.....
Council Regulation establishing common rules for direct support schemes under the common agricultural policy and establishing certain support schemes for farmers – 1782/2003 EEC.
.....

.....
Regulation 166/2006/EEC of the European Parliament and of the Council of 18 January 2006 concerning the establishment of a European Pollutant Release and Transfer Register and amending Council Directives 91/689/EEC and 96/61/EC - 166/2006/EEC.
.....

.....
Council Directive prohibiting the placing on the market and use of plant protection products containing certain active substances - 79/117/EEC.
.....

.....
Birds Directive-Council Directive of 2 April 1979 on the conservation of wild birds- 79/409/EEC.
.....

.....
Council Directive 80/68/EEC of 17 December 1979 on the protection of groundwater against pollution caused by certain harmful substances.
.....

.....
Council Directive 85/337/EEC of 27 June 1985, on determining the effects of certain public and private projects on environment.
.....

.....
Council Directive of 12 June 1986 on the protection of the environment, and in particular of the soil, when sewage sludge is used in agriculture - 86/278/EEC.
.....

(Urban Wastewater Treatment Directive-Council Directive of 21 May 1991. concerning urban wastewater treatment - 91/271/EEC.
.....

Council Directive of 15 July 1991 concerning the placing of plant protection products on the market - 91/414/EEC.
.....

Directive concerning the standardising and rationalising of reports on the implementation of certain directives relating to the environment - 91/692/EEC.
.....

Council Directive of 12 December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources (Nitrate Directive) - 91/676/EEC.
.....

Council Directive of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora - Habitats Directive - 92/43/EEC.
.....

Commission Decision of 24 October 1994 concerning questionnaires for Member States reports on the implementation of certain Directives in the waste sector (implementation of Council Directive 91/692/EEC) - 91/692/EEZ.
.....

Council Directive 96/61/EC of 24 September 1996 relating to the prevention and control of integrated pollution.
.....

Amendment to the Directive of 3 November 1998 on the quality of water intended for human consumption - 98/83/EEC.
.....

Directive of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy - Water Framework Directive) - 2000/60/EEC.
.....

Directive 2001/42/EC of the European Parliament and Council of 27 June 2001 on determining the effects of certain plans and programs on the environment.
.....

Directive of the European Parliament and the Council of 23 October 2001 on national emission ceilings for certain atmospheric pollutants - 2001/81/EEC.
.....

.....
Directive of the European Parliament and the Council of 8 May 2003 on the promotion of the use of biofuels or other renewable fuels for transport - Directive on Transport Biofuels - 2003/30/EEC.
.....

.....
Directive 2003/35/EC of the European Parliament and Council of 26 May 2003. As a provision for public participation in respect of the drawing up of certain plans and programmes relating to the environment and amending with regard to public participation and access to justice Council Directives 85/337/EEC and 96/61/EC - Statement by the Commission.
.....

.....
Directive 2004/35/CE of the European Parliament and Council of 21 April 2004 on the environmental responsibility in terms of prevention and remedy of environmental damages.
.....

.....
Directive 2006/11/EC of the European Parliament and Council of 15 February 2006 on pollution caused by certain harmful substances discharged into aquatic environment of the community (modified version) (text of EEA relevance).
.....

.....
Council Directive of 15 July 1980 relating to the quality of water intended for human consumption (80/778/EEC), (OJ L 229, 30.8.1980, p. 11)
.....

.....
Conventions on wetlands of international significance, especially as a habitat of wetland birds (Ramsar, 1971).
.....

.....
Convention on the protection of the European wildlife and natural habitats (Bern, 1979).
.....

.....
UN Convention on bio-diversity (UNCBD) (Rio de Janeiro, 1992).
.....

.....
UN Convention to Combat Desertification (UNCCD) (Paris, 1994).
.....

.....
Convention on Long-range Trans-boundary Air Pollution, 1979, on further reduction of sulfur emission (Oslo, 1994).
.....

.....
European Landscape Convention - ELC (Strasbourg, 2000).
.....

.....
Convention on Persistent Organic Pollutants (Stockholm, 2001).
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United Nations Framework Convention on Climate Change Declaration - UNCCC
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.....
Protocol on Persistent Organic Pollutants, (Arhus, 1998).
.....

Protocol to Abate Acidification, Eutrophication and Ground-level Ozone, (Goeteborg 1999).
.....

Kyoto Protocol with the Framework Convention of UN on Climate Change (Kyoto, 1999).
.....

White Paper on Renewable Sources of Energy - COM 97/599.
.....

The Pan-European Biological and Landscape Diversity Strategy, PEBLDS), III. European Ministerial Conference for protection of environment "Environment for Europe" (Sofia, 1995).
.....

European Action Plan for Organic Food and Farming - COM (2004) 415 final.
.....

EU Thematic Strategy for Soil Protection-COM (2006) 231 final.
.....

Sixth environmental action programme (6EAP).
.....

Fifth Ministerial Resolution on Biodiversity (Kiev, 2003).
.....

5. SUSTAINABLE MANAGEMENT OF NATURAL RESOURCES

Natural resources imply all the components of nature, i.e. all material assets and useful sources within a natural environment. The French word *ressource* has a dual meaning – supplies, means and sources of supplies, sources of income.

The natural resources are critical to man and his existence. During the entire history of human society, various technologies were employed typical for a specific period, and each one of them involved consumption of natural resources. Practically, their consumption had started way back in prehistoric time. Numerous wars were waged over the ownership of resources (water, oil, land, mines, etc.) in the past, and unfortunately, are still waged today.

A sustainable management represents the method which implies that biological systems stay diversified and functional in time. To humans, this is a potential for a long-lasting maintenance of wellbeing which depends on the wellbeing of the natural world and responsible utilization of natural resources. Due to a huge pressure by the population, daily changes that occur in all segments of life, and particularly due to different desires and requirements of consumers for the utilization of current resources, it is necessary to approach planning of the utilization of natural resources in a very serious fashion. The return to using natural resources within the boundaries of sustainability is one of the top challenges human society has been faced with, and it will require full engagement of all segments of our society.

.....
The Law on Environment Protection (Official Gazette of the Federation of Bosnia and Herzegovina, No. 33/03) provides definitions related to sustainable utilization of natural resources.
.....

Natural resources are components of nature or its constituent parts that can be used for satisfying the needs of society, with the exception of anthropogenic environment.
.....

The components of natural environment include land, ores, surface and ground water, atmospheric air, plants and animals, ozone layer and anything else that provides optimal conditions and wellbeing of the Earth's living organisms.
.....

Sustainable utilization represents the method of using nature's components in the way and to the extent which does not exhaust their regeneration abilities or lead to depletion of natural resources and biological diversity, therefore, it represents their inherent potential for meeting the requirements and demands of the current as well as future generations.
.....

Sustainable development is a system of social and economic conditions and activities that protect wildlife and artificial environment for the current and future generations; utilization of natural resources in a cost-effective and appropriate way in terms of preservation of ecosystems; and, provision of the improvements of standard of life and long-term preservation of biological and cultural diversity from the aspect of ecosystem as a whole.
.....

The resources are usually divided into material, information, natural and working ones. The actual subdivision of resources is the one within the context of sustainability. Natural resources, in general, include all renewable and non-renewable resources of the Earth. The renewable resources comprise water, wind, sunlight energy, mechanical energy, geo-thermal energy, biomass, tidal energy and any other having the ability of regeneration (renewal). The non-renewable natural resources include oil, coal, minerals (precious and non-precious metals), natural gas, soil, etc. A non-renewable resource is a natural resource which once used cannot be used again in the same way and intensity.

Resources involved in commercial utilization provide for economic and social progress and take part in the establishment of natural/social systems.

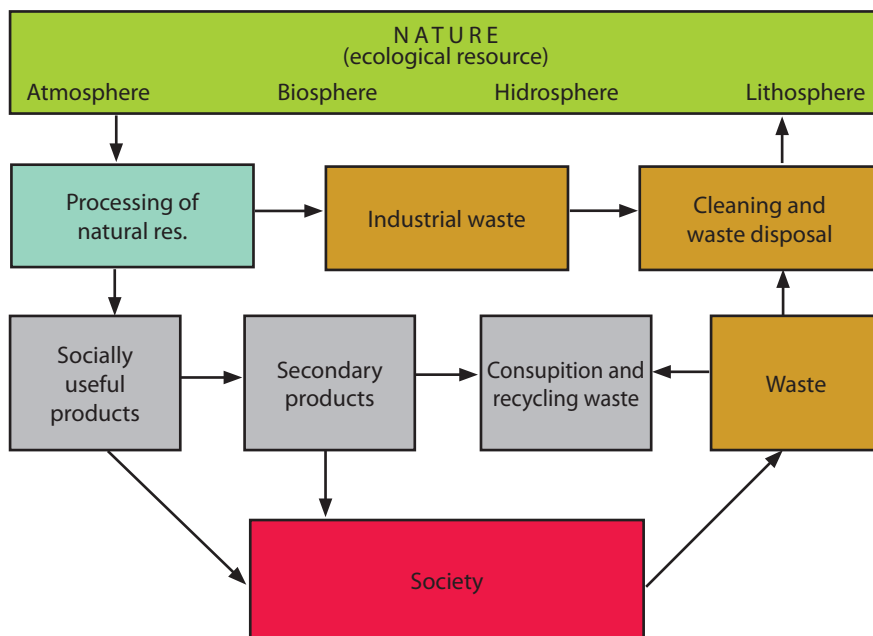


Chart 2: General diagram of interaction between society and nature
(Kavešnikov et al., 2006)

SUSTAINABLE DEVELOPMENT

Definition of sustainable development cited in the World Commission on Environment and Development report from 1987, dubbed *Our Common Future* reads: "sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs". This definition still serves as a foundation for the efforts of the international community aimed at protection and preservation of environment.

There are some other definitions of sustainable development too.

Sustainable development is development which provides a higher level of life quality for everyone, both now and in the future.

Sustainable development is an establishment of a better world by balancing social, economic and ecological factors.

Sustainable development must be initiated by every individual; it begins with an individual's change of personal values and continues through a transfer of such values into all areas of their activity, that is- all areas of their life.

The concept of sustainable development implies "a process of change in which the exploitation of resources, the direction of investments, the orientation of technological development; and institutional change are all in harmony and enhance both current and future potential to meet needs and aspirations of present and future generations.

Basic characteristics of sustainable development are as follows:

- recycling (re-use) of secondary raw materials,
- reduced emission of aggressive and harmful substances into environment,
- reduced consumption of non-renewable natural resources,
- protection of environment becomes an integral part of development process,
- general public has free access to information on the status of environment protection,
- passage and enforcement of legal standards and regulations pertaining to environment protection,
- application of the precautionary principle in the process of environment protection and
- systemic approach to resolving sustainability related issues.

The sustainable development includes achievement of several objectives:

- social development which recognizes everybody's needs,
- effective protection of environment and rational use of natural resources and
- maintenance of high and stable level of national growth and employment.

The modern day understanding of the concept of sustainable development is gradually spreading through the establishment of close relations among scientific disciplines of economy, ecology and sociology, or a combination of social equity, economic security and ecological balance.

Economical security involves:

- increase in productivity and production of useful resources and services,
- reduction of poverty and fulfillment of humans' basic needs,
- just distribution of benefits, profit or resources,
- provision of jobs, wages, new investments, trade and distribution of commodities,
- provision of innovativeness, entrepreneurship,
- adjustment to decentralized world market.

Social equity includes:

- provision and encouragement of cultural diversity,
- establishment of and support to the social system institutions,
- support to social equity and gender equality,
- participation in decision making processes in all spheres of society
- equal education opportunities for everyone,

Ecological balance implies:

- provision and maintenance of genetic diversity,
- support to biological production and environmentally acceptable technologies,
- development of resistance to negative impacts on environment,
- promotion and enabling of environmental recovery in case of negative impacts,
- provision of clean environment and stable climate (preemptive action aimed at preventing the climate change), and
- encouragement of eco-efficiency in all segments of the society.

Since sustainable environment requires integration of environmental, social and economic factors, the process of planning economic development should:

- integrate environment and development at the planning and management levels,
- establish the natural resources budgetary systems that would provide the creators of economic policy with accurate data on the capacities of a given national economy,
- create effective legal and regulatory systems at all levels, aimed at transition from the transformed environment and development policies to action,
- provide effective use of economic and market instruments through the establishment of the “polluter pays” principle, which dismisses the wrong concept that environment is a free asset.

AGENDA 21 AND SUSTAINABLE MANAGEMENT

The Earth Summit held in Rio de Janeiro is considered the conference that takes a place of honor in the history of environment protection. The Agenda 21 is one of five key documents adopted at this conference. The Agenda 21 is a historic document that explains the actions to be taken in order to make development sustainable from ecological, economic and social aspects. This achievement requires all elements of the society to get involved. This document offers some specific measures and recommendations for action in 40 different areas (environment protection: soil, forest, water and air; conservation and protection of biodiversity, sustainable use of natural resources and sustainable management of environment). It is a general agenda for the intentions and responsibilities related to actions aimed at accomplishment of the ultimate goal – sustainable development in the 21st century. The Agenda 21 does not include any restrictions or obligations, just suggestions and recommendations. It comprises 40 chapters divided into four main sections, one of which addresses rational use of resources (rich world) and from which stem the basic management principles for the key natural resources at local level – forest, agriculture, water, waste. Additionally, the Agenda 21 lists 9 basic social groups (women, children and youth, native population, non-governmental organizations, local authorities, workers and trade unions, business world and industry, scientists and farmers) whose actions are crucially essential for sustainable development of Earth.

Main Areas of the Agenda 21

- **Achieve growth in a sustainable way (Prosperous world)**

While planning economic development it is necessary to:

- integrate environment and development at the level of planning and managing,
- establish a natural resources budget system,
- create effective legal and regulatory systems at all levels,
- provide effective use of economic and market instruments by establishing the “polluter pays” principle.

- **Sustainable way of living (Just world)**

- Combating poverty
- Change of consumption patterns (reduce consumption of material, energy and waste making; adopt programs that encourage sustainable production, encourage environment friendly technologies)

- **Demographic movements and sustainability**

- **Protection and improvement of human health**

- Provide a health care system that would follow up and foresee the occurrence of infectious diseases (develop a system of health care in small communities – rural settlements; ensure health care for children, control distribution and application of pesticides – reduce health risks)

- **Human settlements (Inhabited world)**

- Development of the concept of sustainable settlements (supply of fresh water, protection and improvement of human health, change of consumption patterns)
- Management of solid waste and drainage (by the year 2005: ensure in developing countries that not less than 50% of all waste water and solid waste are treated and disposed in accordance with national and international environmental standards, provide all urban areas with proper services in charge of waste, and, implement sanitation activities in rural areas, reduce production of hazardous waste)

- **Rational use of resources (Rich world)**
 - **Sustainable management of soil:** develop national programs which appreciate soil as irreplaceable natural resource; develop and enforce legal regulations which provides sustainable use of soil; ecological planning of landscape, e.g. use of a river catchment; managing the soil by using traditional and autochthonous methods; limit and stop soil degradation during tillage.
 - **Sustainable management of waters:** conduct continued search for new sources of water; protect water resources and ensure that its use is sustainable; assess the impact of new development programs on status and quality of waters; develop methods for fresh water supply from various sources (collection of rainfall, re-use of waste waters, water recycling, etc.).
 - **Agriculture** – improvement of sustainable agriculture and rural development include the following: planned approach to agricultural; education; increased crop farming aimed at increased production of food; support to production on farms; use and sustainable use of plants and genetic engineering; information on use of pesticides; transition to the most acceptable forms of agricultural production (organic or ecological); transition to alternative sources of energy aimed at increase of productivity (flow-based hydropower plants, grain mills, windmills, solar collectors, etc.).
 - **Forest:** increase plantation of forests thus decreasing pressure on primary and ancient forests; grow trees that are characterized by high production rate and resilience; protect forests from wildfires, poaching and other types of degradation; use efficient and ecologically acceptable methods of felling; reduce wood waste and use abandoned and neglected tree species; develop urban forestry for the purpose of greening all inhabited locations; encourage development of small forestry companies that would support rural development; develop modern methods of wood processing and reduce degradation of original mass.
 - **Biodiversity:** develop national strategies for protection of biodiversity; endorse international and regional cooperation within the field of biodiversity; support restoration of disrupted ecosystems and rehabilitation of damaged areas; develop programs for scientific and technological education and training of environment protection managers.

- **Biotechnology:** use various bio-technological methods to increase yields of fish, algae and other species; use traditional biotechnology in food production and processing of raw materials; intensify biotechnological methods for production of energy (flow hydropower plants, windmills, solar collectors, geothermal energy, etc.); improve biotechnological knowledge in order to replace the existing chemical processes.

- **Global and regional resources (World of common interests)**
 - **Protection of atmosphere:** build a system for forecasting various levels of atmospheric pollutants which could cause change of climate system and environment in general; modernize the existing energy systems that would have a higher level of energy efficiency and lower level of atmospheric pollution; assist in educating citizens about development and utilization of more effective energy sources that are less polluting to the atmosphere; develop a program for valorization of energy efficiency in consumers; develop a system of suburban transportation that would be less polluting to the environment; encourage and develop those industrial technologies that have least negative impact on atmospheric pollution, and implement them in practice (take positive examples of clean technologies used in practice).

 - **Oceans and seas:** develop plans for man-made and natural disaster induced degradation contingencies; have good knowledge of the effects of sea-level rise and climatic characteristics; protect oceans, seas and coastal lines from pollution from ships, especially their illegal debarkation, discharge of pollutants; take action concerning the protection and preservation of endangered types of rare ecosystems, such as coral reefs; provide training in proper protection from oil and chemical waste in cooperation with chemical and oil processing/producing industries.

- **Waste and chemicals management (Clean world)**
 - **Toxic chemicals:** there are two major problems that mainly occur in developing countries: lack of scientific information required to assess risk from use of a large number of chemicals; and, lack of resources for assessing the risk from chemicals' harmful effects.

- **Hazardous waste:** industries should be continuously requested to seek innovative ways for achieving a cleaner production (preemptive technologies, recycling technologies, etc.) and assisted in doing so; ensure gradual abolishment of those industrial processes that are highly risky to the environment; establish permanent control of agricultural producers (what actions do they take with regard to environment protection); make producers liable for disposing their waste; inform the public about all the issues of this kind in order to not just take preemptive measures, but establish a system of continued education of citizens about this type of problems; build plants for treatment of hazardous waste at state or regional levels and link them to rural areas; waste should be processed, recycled, re-used and disposed of in an environment friendly way.
- **Radioactive waste:** reduce and limit the production of radioactive waste. Ensure a safe way of storing, processing, conditioning, transporting and disposing this type of waste; provide technical support to developing countries as to how to address the issue of radioactive waste; improve planned management of waste in a safe and environment friendly way; follow through the Code of conduct for trans-boundary movement of radioactive waste; prevent storing and disposing of radioactive waste in the vicinity of the sea coast or at the open sea; prevent the export of this waste into the countries that ban its import.
- **Division of human roles and responsibilities (World of humans and their activities)**
 - Targeting specific groups of people aimed at raising their awareness, education and training required for the implementation of the Agenda 21, e.g.: women; youth; farmers; local decision makers; non-government organizations; trade associations; business sector and industry, scientific and technological associations.

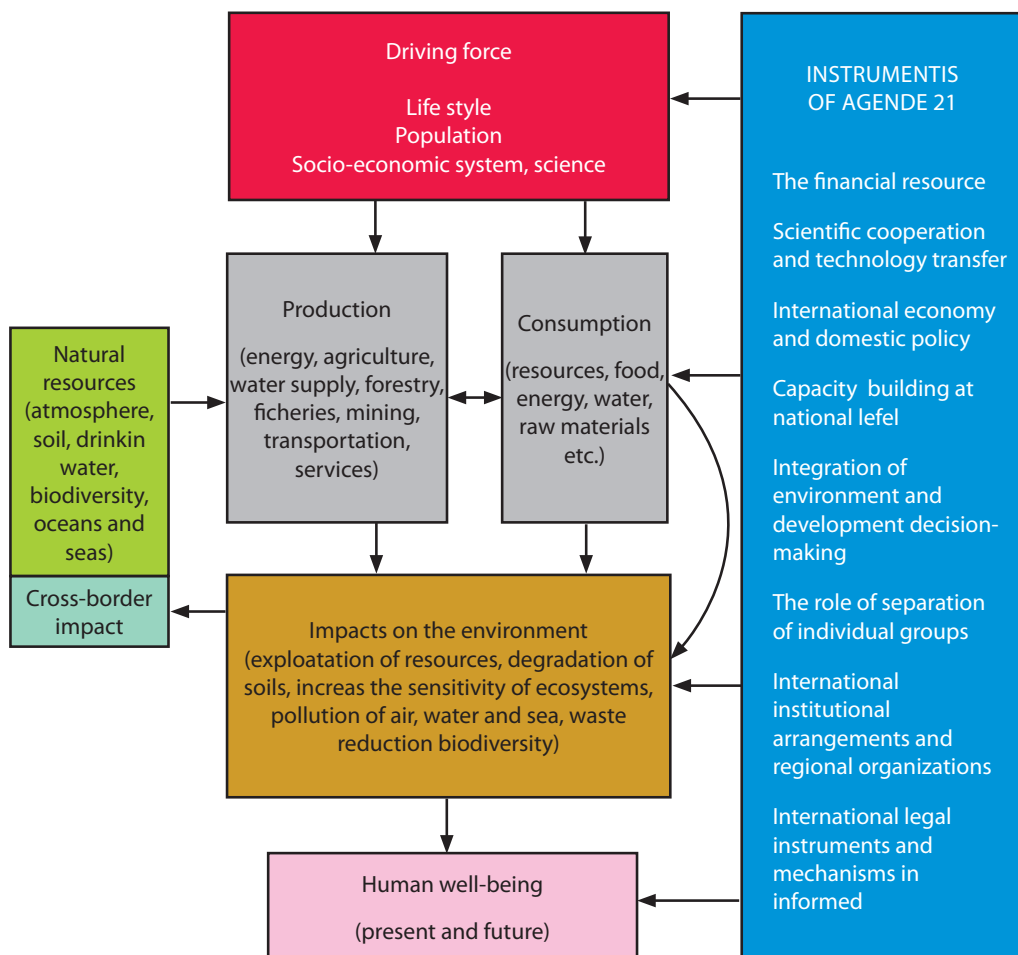


Chart 3: The Agenda 21 General Framework

ENERGY RESOURCES

The energy resources are essential to sustaining the life on Earth, as well as development of human civilization. Each one of the activities consumes certain form of energy. Practically, the modern day life is not conceivable without energy: electric, thermal, oil, gas, etc. Energy is essential to many technological processes as well as all kinds of human activities: health care, education, tourism, civil engineering, transportation, communications, etc.

Any kind of planning (economic, social, spatial, physical) foresees consumption of a certain amount of energy. Since every type of planning targets progress and development of a specific area, it also has to respect and comply with the principles of "sustainability".

Today, in many places of our environment there are already built energy facilities that are pollutants as well, whose harmful effects need to be reduced. For this reason, it is necessary to have a good understanding of fundamental concepts, principles, types and options for the application of energy.

Energy can be divided based on different criteria:

- origin (natural and artificial),
- way of production (primary and secondary), and
- function (mechanic, thermal, electric, electromagnetic and nuclear).

Nowadays, two approaches to defining human attitude toward energy in the future impose themselves as imperative:

1. necessity to strive toward maximum saving, i.e. increase of energy efficiency and
2. use renewable and permanent sources of energy.

It is also important to seek new, best possible types of energy.

The EU member countries committed themselves to increase the participation of renewable sources of energy from 8.5% in 2005 to 20% by 2020. This increase of the share of renewable sources of energy is a necessary contribution to combating global climate changes and a huge step toward a higher energy independence of the Union. Renewable sources of energy at local level may significantly contribute to the reduction of global warming, since their use is related to small or zero emission of CO₂.

In the context of sustainability, energy resources are generally subdivided into:

- renewable (biomass, sunlight, wind, geothermal energy, sea tide, hydro energy), and
- non-renewable (fossil fuels).

Biomass (vegetation, animal and municipal waste) is categorized as a renewable biological resource along with human and animal power (mechanic work). Biomass as a renewable energy source may be of plant or animal origin. It is also

referred to as a *sleeping giant* and is considered as fuel of the future. The best known and widely spread way is the use of wood mass for heating homes. In industry, biomass is used as an auxiliary source of heat or electric power, which increases the overall cost effectiveness.

The plant organisms performing photosynthesis have accumulated and kept the sunlight energy more than two billions of years. Plants absorb around 0.1 % of the total sunlight coming to the Earth's surface. This kinetic energy is by the process of photosynthesis transformed into chemical energy in organic molecules. More than a half of energy collected by plants is consumed by metabolic activities (nutrition of cells, reproduction), while the rest is stored in biomass. In addition to the biomass of plant origin, it is also used the biomass of animal origin, such as feces residue, waste from farms used in the process of fermentation to produce fuel known as biogas. Biogas can be used for heating or production of electric power. When purified, biogas can be used as gaseous bio-fuel. Biomass can also be used in production of liquid bio-fuels – biodiesel and bio-ethanol. The European Union recommended that 10% of traditional diesel and petroleum fuels be replaced by biofuels by 2020, provided that the factors of biological diversity and sustainable development in this field are fully respected.

Solar energy is an inexhaustible source of renewable energy. The amount of sunlight energy reaching the Earth every day is approximately 600 times bigger than total daily energy output of all other energy sources (Enger et al., 1989). The effective use of sunlight energy depends on meteorological/climate conditions of a given region and level of development of the existing technology. By number of sunny days, the world's first place is taken by Africa and Central Asia. Solar energy can be used for heating or production of electric power. The solar collectors (panels) installed on the house roof can fulfill most of the requirement for hot water, and heat can be used for heating the house space. It is estimated that in 2006 more than 20 million m² of solar panels were installed across Europe, not only in its southern parts. Additionally, solar energy can be converted into electric power in solar power plants.

Grain mills and windmills used in the past actually produced mechanical energy from hydro energy and wind energy. Modern versions of such devices convert water or wind energy into electric power. Small scale flow hydro-power stations or those within the systems with huge dams – the principle is the same, potential or kinetic energy of water is transformed into electric energy.

The European production of electric power by using wind energy, which has made a considerable progress over the past few years, is today at the level of requirement for electric power in Denmark and Hungary combined. The wind energy is the most rapid growing source of renewable energy in the world. However, just like any other energy sources, it has both negative and positive sides. According to a recent comprehensive research of onshore wind power plants in Great Britain, the major

problem about these power plants is their efficiency. According to the subject research, more than 20 windmill plants in the United Kingdom produce less than one fifth of their maximum capacity, while two windmills produce even less than 10% of their maximum capacity. The acceptable standard for the windmill farms, i.e. wind-power plants ranges between 25% and 30%. Such results provide arguments to the people opposing utilization of wind energy, claiming that that many windmills produce way too little energy which could justify their impact on the environment and its visual (esthetic) pollution. On the other hand, some experts warn that these results are to be read with certain caution as they may considerably vary from year to year and are subject to numerous factors.

In **geothermal energy**, a system of heat pumps several meters beneath the ground surface utilizes heat from the Earth's depths. This is a relatively new, though promising technology.

BASIC PRINCIPLES OF FOREST MANAGEMENT

The forest ecosystems are stable ecosystems of the final stages of ecological succession. In forest ecosystems, and in other systems alike, the living organisms are interrelated and influenced by abiotic factors (soil, relief, climate), and vice versa.

Major functions of the forest ecosystems are as follows:

- Production and filtering of oxygen – (forests provide about ½ of total oxygen on the Earth);
- Absorb and fixate carbon-dioxide (CO₂): (1 ha of vegetation absorbs 8 kg CO₂);
- Impact general humidity;
- Maintain soil humidity (reduce soil evaporation);
- Regulate level and quantity of ground water;
- Transform precipitation, thermal and air currents;
- Absorb dust (depending on type from 0.5 to 5 gr/m²);
- Provide shelter from wind, noise, etc.;
- Habitats, shelters, protection, resorts (birds, hedgehogs, game, etc.);
- Protection of soil from erosion, leaching, etc.;
- Impact formation of microclimate.

Just like water ecosystems, the forest ecosystems are the „guards“ of biodiversity on the Earth. Depending on the type of predominant vegetation as well as on some abiotic factors (soil, climate, water regime, etc.), forests are homes to a vast number of plant and animal species. The significance of forest ecosystems to biodiversity is huge, since they often represent inimitable and unique habitats for many species.

The benefits local population has from the forest ecosystems include:

Source of diverse food (water, wild game, forest fruits, mushrooms, snails),

Source of medicinal plants,

Development of recreational and sport activities: hunting, fishing, excursion sites, hiking, competitions,

Source of heat energy: firewood,

Building materials: houses, agricultural facilities (stables, cots), facilities for storing agricultural crops (barns, maize crib, potato-pits, etc.),

They sustain biodiversity,

Grazing area for domestic animals and

Protection from droughts and floods, etc.

Though appearing as sturdy and stable, the forest ecosystems are very sensitive and vulnerable to various types of natural and anthropogenic impacts. For example, it takes a forest several years to recover and go back to normal after being affected by fire or deforestation. The forest ecosystems may be threatened by natural (erosion, water, wind, fire) and anthropogenic factors (felling, fire, developing). For this reason, management of forest ecosystems must be performed in compliance with both scientific and professional principles aimed at protecting and preserving their biological diversity. Positive measures, in a broad sense, imply the following activities:

- Development of an assessment of the vulnerability of forests as well as a plan of protection for each forest-economic area,
- Development of a single plan of protection of the forests from wildfire at largest localities and stationing of certain tools for detection and localization of forest fires,
- Permanent monitoring and screening of the health condition of the forest areas and development of an analysis based on previous status,
- Continuous sanitary felling of diseased trees and regular renewal and planting of new trees (afforestation),

- Protection of forests from illegal felling and harmful diseases which affect forest resources, and
- Permanent improvement of technical resources used for protecting the forests from fire and chemicals which are applied in pest control in forests.

The management of forests is much more affected by the measures out of the forestry sector, such as the policies and institutions of trade, macroeconomic policy, as well as the policies of other sectors, to include agriculture, infrastructure, energy and mining, than the measures passed within it. Some of the proposed protective measures for the forest ecosystems imply:

- management in accordance with the principles of sustainable development,
- provision of a constant percentage of mature, aged, dry and tree cavities,
- conduct a continuous afforestation,
- protect forest margins and clearings (grassland),
- not allow introduction of allochthonous species,
- preserve autochthonous and endemic tree species
- take care about wild forest species (plant and animal),
- avoid use of harmful chemicals, and
- perform a mandatory systemic and continuous monitoring – forest monitoring.

Bosnia and Herzegovina is a country with diverse deciduous and coniferous ecosystems. There is also a lot of shrubbery which actually represents a transitional stage toward forest ecosystems. It has the following types of forest ecosystems: beech forests, hornbeam forests, oak forests, chestnut groves, pine forests, and many others. It is evident a large number of forest ecosystems of mixed type (hornbeam-beech forest, etc.).

The BH forest ecosystems are characteristic for their heterogeneous land cover, various erosion processes, and unusual relief forms. Many of the forest ecosystems are situated on very steep inclinations and rocky terrain. The most common limiting factors include inaccessibility, steep slopes, shallow soil, and rockiness. However, these „disadvantages“ may at the same time be huge advantages in terms of beauty and diversity of forest landscape.

BASIC PRINCIPLES OF WATER MANAGEMENT

Water has a great significance for the survival of entire biosphere and its biotic and abiotic ecological components. It is essential to many individual organisms in various ecosystems, but primarily to: humans, animals, plants, as well as many types of microorganisms. Its significance is reflected through the following:

- enables seed germination,
- influences growth and development of plants,
- enables process of transpiration and
- helps in forming ecological shapes and properties of plants, and in this sense we distinguish:
 - hydrophytes – plants adapted to permanently live in water (algae, duckweed, etc.),
 - mesophytes – plants growing in habitats with moderate water supply (deciduous trees, moss, herbaceous plants) and
 - xerophytes – grow in a habitat that lacks water (rockery plants, semi-desert plants, cacti, etc.).

The natural water resources have a particular value in rural areas. These include water sources, surface and ground waters, mineral and thermal waters, etc. Streams and rivers, along with soil, are main recipients of untreated waste waters from the nearby rural settlements. In terms of sanitary standards, water in the upper parts of the watercourses usually have good quality, while middle and lower course are often polluted by various pollutants (organic and inorganic). Sustainability can be achieved by introducing the *polluter pays* and *consumer pays* principles (cost for using and discharging waters into environment).

In the high-mountainous regions with rural settlements of Bosnia and Herzegovina, it is usually the lakes that provide reservoirs of fresh water that are still preserved thanks to sustainable animal farming and eco-tourism. The Prokoško Lake near Fojnica is such an example. However, the recently intensified construction work around the lake, as well as the pressure of an increased number of tourists, have inevitably made a serious negative impact on the status of environment surrounding this magnificent monument of natural beauty.

The principles pertaining to sustainability, including waters too, comprise three well known components:

- ecological (environmental sustainability),
- economic (economic value and financial cost effectiveness) and
- social (social development and stability).

Catchment is a basic territorial entity within which use and protection of soil and water should be organized. Method of soil use has the largest impact on the destiny of the catchment's water. Sustainable management in the upper parts of the catchment results in unloading and reducing the issues of erosion, runoff and floods downstream. Conservation of water and soil begins with the very first drops that fall in the upper part of the catchment. One of the basic principles is to reduce initial outflow to the benefit of infiltration and retain water in the soil (water retention).

An inevitable prerequisite for intensive and stable agricultural production is regulation of the soil water regime through the application of principal hydromelioration measures of irrigation and drainage. During the year, due to non-harmonized ratio between precipitation and PET (potential evapotranspiration) in Bosnia and Herzegovina, we have the occurrence of water surpluses and shortages. Surplus of water occurs in the colder part of the year (northern Bosnia and Herzegovina has a surplus of 200 mm) therefore, drainage is required. Shortage of water in summer time (100 mm in northern Bosnia and Herzegovina) requires the need for irrigation.

Utilization of land with the application of irrigation allows above all:

- broader selection of agricultural crops during the vegetation, especially early vegetables,
- two or three yields during the vegetation period per unit of the area and
- secure and stable agricultural production which excludes variations in yield.

Irrigation opens up opportunities for an intensive utilization of agro-ecological and technical conditions. The application of this measure is no longer limited to only arid or semi-arid areas and dry years. Irrigation is a widely applied practice in rural areas; therefore, close attention has to be paid to the quality of water used for irrigation (streams, rivers, wells, etc.).

In the case that irrigation is not possible or available; the only solution lays in proper management of the soil water reserves, which implies:

- proper utilization of steep slopes, contour farming and terracing aimed at increase of water conservation in the soil for the purpose of reducing erosion and creating moisture reserves for dry period of the year,
- selection of crops and crop rotation adjusted to fit the soil type and its water regime,
- use mulching to reduce evaporation being an irreversible loss of moisture,
- improve retention property of the soil by applying measures typical for organic production and
- reduced soil tillage.

Another measure commonly implemented in rural areas is drainage of surplus water by a network of canals. In order to keep this drainage at a quality level, it is necessary to maintain the system regularly as the canals and beds of the final recipients are often overgrown by vegetation, glutted or plugged with various solid waste.

Measures related to the protection of waters from pollution can be divided into preemptive and repressive. The preemptive ones are undoubtedly of a way bigger significance, since they are intended to remove the possible causes of water pollution.

Listed below are some of the major measures aimed at protecting water from pollution:

- classification and categorization of water,
- prescribed standards on water quality,
- undertaking of water protection sanitation measures,
- issuance of permits and licenses for the construction and reconstruction of facilities which could possibly pollute water,
- introduction of waste water taxes, charges and fees,
- installation of water pollution control devices, et.

Bosnia and Herzegovina is rich in ground waters which provide 80-90% drinking water. It also has a total of 26 major or minor water accumulations. Most these accumulations are built for the purpose of producing the hydro energy. These accumulations are also important with regard to the regulation of water regime (reduced flood and increased minimum rate of outflows), as well as the provision of water required for supplying the population and irrigation in agriculture.

Many sources and ground accumulations of mineral waters meet the quality standards required for commercial exploitation. One such source is the Kiseljak in Kiseljak – where our famous mineral water comes from. Additionally, there are numerous thermal springs such as Fojnica, Teslić (Banja Vrućica), Gata, Olovo, Srebrenica (operation interrupted due to war effects, Banjaluka (Trapisti), Kozarska Dubica (Mlječanica), Laktaši (Slatina) that are adjusted to commercial exploitation as spas. Despite these relatively positive examples, relatively small number of mineral and thermal springs is commercially exploited; they are usually not used at all though they represent specific resources of huge importance in the area of bottled mineral water industry and development of health tourism.

BASIC MANAGEMENT PRINCIPLES IN AGRICULTURAL PRODUCTION

Agriculture is an economic activity based on utilization of land areas and is a foundation for development of rural space. Recently, the sustainable agriculture has started to receive more attention as a sole acceptable orientation of economic development in the new millennium. The agricultural policy (Common Agricultural Policy - CAP) of European Union based upon two “pillars”:

1. market and incomes policy – farmers’ competitiveness and
2. sustainable development of rural areas.

To base the production on these two pillars means to seek balance between the market competitive agricultural production and protection of environment. The explosive growth of the population in developing countries on one, and rapid progression of general standard of living in the developed countries population on the other side, produce an ever growing pressure on the resources the agriculture relies on, primarily the soil as non-renewable (due to slow process of renewal) natural resource.

Two key aspects are currently in the focus of the decision makers, general public, agricultural science and practice, and these are:

1. Availability of food (Food security), and
2. Food safety.

The nineties of the 20th century were characteristic for, at the time, a new approach to agriculture based on the „sustainability“ of the ecosystems and rural areas, which is currently known as „Sustainable agriculture and rural development“ (*Sustainable Agriculture and Rural Development – SARD*). The main objectives of this approach include:

- sustainable development of agriculture, forestry and fishery,
- conservation and protection of soil, water, plant and animal genetic resources and
- employment of the best available techniques and technologies in practice (BAT) which avoid negative impact on the environment.

In identifying and providing the guidelines for sustainable management and exploitation of land resources, there are several courses that can be taken, yet they all inevitably link the soil, climate, methods of land use and particularly the socio-economic state within the area of interest.

The new concept of agricultural development was promoted in Maastricht, 1999, at the *Multifunctional Character of Agriculture and Land* (MFCAL) conference, while today it has the leading position within the agricultural sciences and ecology. The overall concept integrates the three aspects: environmental, economic and social, while insisting on the so-called Acceptable Agricultural Management Code. An important role within this concept is played by the indicators of sustainable land management, the so-called agro-ecological indicators based on which the level of sustainability of a specific intervention applied in agricultural practice is determined.

According to this concept, agricultural production in rural areas should be viewed and planned as an activity whose structure and main characteristics are in direct relation with the population density of the specific parts. Additionally, it should be considered as an activity which addresses some of the social issues, to include employment. An important social indicator is related to the average age of the members of rural households and size of the farm, which has direct impact on the possibility of optimal use of land as a conditionally renewable natural resource.

The *Multifunctional Character of Agriculture and Land* management is not yet sufficiently emphasized or valued. The concept of the multifunctional character of agriculture and land should acknowledge the diversity of natural conditions for agriculture, as well as for other economic activities being the sources of income to the rural community: rural tourism, recreation, sport fishing, hunting tourism, etc. Pursuant to these conditions, it is necessary to create socially, economically and ecologically acceptable interventions in agriculture and land management.

In Europe and the world, there are several different systems of approach to agricultural production:

- Intensive (conventional) agriculture,
- Sustainable agriculture and
- Ecological (organic) agriculture.

Intensive Agriculture

The intensive agriculture is still the most common and most influential form of agricultural production at the global level. Man, as an ecological factor, has adjusted this type of production to his needs and interests aimed primarily at making profit while neglecting the quality and sustainability of the agro-ecosystem.

The intensive agriculture is market oriented agriculture with a clearly defined goal – high profit and market competitive product (cheap inputs for the food and processing industries in general). In other words, its objective is to produce as much products as possible with the minimum use of labor, energy and resources.

The farms raising domestic animals have developed the elements of industrial production; animals are mostly kept in confinement and fed with what man provides them - „bagged animal feed“. This system causes the agricultural production to lose its traditional self-sufficiency when it comes to the production of their own animal feed, organic fertilizers and like, and become increasingly more dependent on numerous external inputs (energy, mineral fertilizers, and pesticides).

Sustainable Agriculture

The principles of sustainable agricultural production comprise the technically feasible, ecologically acceptable, socially responsible and economically effective agricultural development, which will make sure that human requirements for food

will be met, while natural resources will remain preserved, nature unpolluted and biodiversity unthreatened. In other words, it is a civilized and responsible development which will not endanger normal life of the future generations for the sake of profit and wellbeing of the current one. These principles should guide the planning of any agrotechnical, zootechnical, agropolitical and economic measures in the sustainable development of agriculture and food production in the future. This primarily refers to the rational use and conservation of land as the major resource in food production.

The characteristics of this system reflect in the fact that the farms are limited to the individual households and that they are involved in a mixed type of production adjusted to their own needs. Almost all aspects of agriculture are included in a single place: mixed animal (small and large) and poultry farming, composting, mechanical prevention of weed (hoeing), application of manure, green fertilization as well as minimum quantities of mineral fertilizers. The sowing and planting material is based on checked and mostly native varieties though some high-yield hybrids are possible too. They respect the crop rotation and the relation of tolerance among the crops. There is a plenty of food for animals, though the animals also graze in the open. The representation of livestock is 1 conditional cattle head/ha.



Picture 10: The „Buhvača“pear fruits

In Bosnia and Herzegovina this type of agricultural production is common to rural areas, as it is rather similar to the traditional way of farming. A huge downside is related to very little agricultural incentives, insufficient development and poverty of the rural population in general.

Ecological (Organic) Agriculture

The ecological agriculture is a specific system of sustainable management in agriculture and forestry. It involves the ecologically, economically and socially justifiable production and technological methods, interventions and systems. Pursuant to the internationally adopted standards and principles of the most favorable, it uses the soil fertility and available water; genetic potential of the plants and animals; natural characteristics of the landscape; only the prescribed natural fertilizers and substances for the protection of plants and animals.

Throughout the world this type of management system is controlled by the *International Federation of Organic Agriculture Movements* (IFOAM). The production system is accepted by the programs of the United Nations organizations (WHO and FAO), European Union Council, as well as the institutions involved in certification of products produced in accordance with the principles of ecologic agriculture (OK, KRAV, etc.). The European Union member countries provide considerable incentives for organic farming.

The organic farming has a long tradition in Europe; it is based upon the postulates of its founders: *Rudolf Steiner, Hans Müller and Hans Peter Rusch*. Many believe that organic farming is a reliable „guard of environment“. The organic farming tries to implement the concept of multifunctionality in practice, in a specific work and living space, to include biodiversity (Knickle, 2000).

The harshest demands in this system are related to the content of toxic substances. The organic farming generally does not use mineral fertilizers or agrochemicals; animals are not kept in confinement on eco-farms; it uses preparations and respects the crop rotation. It implies maximum utilization of the soil biological resources. It starts from the position that the edaphon (soil organisms) accomplishes numerous tasks in agriculture, such as decomposition, recycling, crop protection, etc. The objective of such a system of management is to protect nutrients in soil and water, and at the same time stimulate the beneficial and repressing the detrimental organisms.

Since organic farmers cannot compensate the loss of fertility in soil by the application of synthetic nutrients, the increase and maintenance of soil fertility is the main task of the organic farming. The results of a research of a multiple-year comparison of relevant soil indicators in organic and conventional soils conducted by the Swiss Research Institute for Organic Agriculture may be summarized as follows:

- The content of organic matter is, thanks to the methods of organic fertilizing, higher in organic soils, which helps in avoiding the soil acidification.
- Organic crops benefit from symbiotic relations and are better poised to utilize the soil.
- Organic management shows a considerably higher level of biological activity (worms, fungi, bacteria, etc.) than the conventional one. Subsequently, it has a faster transformation of nutrients and better structure of soil.
- Higher representation of predators helps in controlling the pest organisms.
- Generally, the organic techniques such as organic fertilizing, mulching and cover cropping improve the soil structure thus inducing the increase of precipitation infiltration and retention capacity, which ultimately reduces the risk from erosion.

A product produced in compliance with this production method is called ecologic. A producer involved in ecologic production has to be registered and his ecologic product certified. A producer may be any legal or physical entity involved in production of ecologic products, their processing or trading. Any ecologic product must have a proper indication.

The ecologic agriculture in Bosnia and Herzegovina has not yet been legally regulated, unlike the EU member countries which adopted the Law on Ecologic Agriculture. In EU and the world, there are numerous organic products marked with specific symbols.



Picture 11: Indication of ecologic product in Croatia

Ecological Agriculture and Biodiversity

Because of the upsetting impoverishment of biodiversity in global agriculture, the Convention on Biological Diversity in 1996 developed a work program aimed at encouraging those agricultural practices that would support renewal and improvement of biological diversity (biodiversity). Such practices include the organic farming. The organic farmers are both keepers and users of biodiversity at all levels:

- Genetic diversity- variations between the individuals and between the populations within the same species; for this purpose recommended is the cultivation of crops adapted to the local climatic and soil conditions, native cultivars, which does not necessarily exclude the high-yielding varieties.
- Diversity of species - presence of diverse plants and animals optimizes the circulation of nutrients and energy within a region or community.
- Diversity of ecosystems - presence of various natural habitats in the areas around and inside the organic fields (grass, forest, margin areas) and absence of chemical substances create conditions suitable for wild animals. The reliance on natural control methods sustains biodiversity and avoids selection of the pests resistant to chemical methods.

A common approach to ecologic agriculture implies:

- Conservation Agriculture (CA),
- Integrated Pest Management (IPM), and
- Integrated Plant Nutrition System (IPNS).

All these elements consider just individual aspects of the farm management components. The ability to define a strategy which combines the above stated elements in a single approach is the characteristic of organic farming. As the organic farmers are not allowed to use synthetic substances, they need to renew the natural ecologic balance where the functions of the ecosystem are their main production “input”.

Crop rotation and crop sequencing, symbiotic association, cover cropping, organic fertilizers and minimum tillage create suitable conditions for the soil flora and fauna and considerably increase the soil biodiversity. We can even speak of dual role of organic farming – production of organic food and preservation of biodiversity.

In organic farming, both means and goals are organic. The improvement of functional biodiversity is the key to ecologic strategy which leads to a sustainable organic production. Biodiversity, being a part of the well balanced organic system, is included in the International Federation of Organic Agriculture Movements (IFOAM).

Sustainable Agricultural Land Management

The world experiences and practice in EU countries point out the fact that proper land management and its protection are the most important actions in the protection and sustainability of the overall agro-ecosystem.

According to the contemporary conceptions, soil is one of the most important and most complex elements of the ecosystem and represents an irreplaceable, non-multiplicative and limited natural resource. It is the cornerstone of agriculture and forestry. The modern concept of management of land as a multifunctional medium (MFCAL) underlines the fact that the soil has the functions/roles that are the foundation to the establishment of a balanced system and sustainability. All the roles are inseparable and equally important, and they include (multi -functionality of soil):

- primary production of food – biomass,
- ecologic-regulatory role (recipient, collector and converter of various matters),
- climate regulation role,
- spatial role - „pillar“ of infrastructure,
- purifier of water,
- source of energy assets and protection of biodiversity,
- shaping of landscape and
- historic medium.

A sound and quality soil is the essential component of sustainable agriculture. To achieve that, soil needs to be protected from all forms of erosion, and the continuous pressure on soil in the sense of its physical loss from the sphere of agriculture or environment has to be reduced. It is particularly important to limit the application of synthetic pesticides whenever possible, while in terms of protection from salinity it is necessary to apply a rational irrigation method.

Generally speaking, when it comes to protecting the soil from pollution, it is necessary to undertake the following measures:

- Limit the use of agricultural land for non-agricultural purposes and prevent pollution by heavy metals, especially in the immediate vicinity of industrial facilities, as well as their disposal on agricultural land.
- Regular analysis of soil fertility and proper application of mineral fertilizers and pesticides.
- Control the infiltration of radionuclides, thorium series and cadmium into the soil.
- Prevent discharge of industrial waste, industrial waste water, silt and urban waste waters onto agricultural land.
- Set priorities for cleaning of land that is already polluted due to improper waste management.
- Organize training of personnel at all levels in protecting the soil and controlling its fertility, i.e. rational application of fertilizers and pesticides.

The way we use the soil directly impacts the appearance of the rural landscape, the possibility of tourism development in rural areas, etc. The sustainable soil management is achieved by adhering to the rules that are defined by ecological standards, that is – *the Accepted Agricultural Practice Rules*– which is a precondition for getting financial support as a „non-market correction mechanism“.

In general, the measures related to soil quality management may be grouped as follows:

- Measures for managing biological soil properties,
- Measures for managing physical soil properties and
- Measures for managing chemical soil properties.

The measures for managing physical soil properties are as follows:

- Vertical deep ploughing
- Pipe drainage
- Irrigation, using water that meets the FAO standards, where the content of mercury should be less than 0,005 mg/kg, and other elements at the same levels that apply to drinking water.

- Soil tillage, which mainly implies the rehabilitation of slightly forgotten soil maintenance, towards reduced and conservation tillage especially in the zone of heavy clay soils and soils undergoing rehabilitation that were previously in public ownership. The conservation practice is based on three principles: permanent coverage of soil with crop residues, minimum tillage or disturbance of soil and crop rotation.

The measures for managing soil chemical properties include:

- Calcification, (adding of carbonate materials to neutralize acidity and improve the water physical properties of soil).
- Humization as a central intervention in sustainable production and a clear *turnover of organic matter* for the purpose of enriching the soil with humus and its permanent maintenance. The mineralized organic matter has to cover the food requirements and compensate for the limited application of mineral fertilizers. To achieve this, we use the plant root residues, green fertilization, manure and compost.
- Increase of the content of accessible phosphorus and potassium through the application of natural phosphates and organic fertilizers.
- Application of specific matters pertains to the matters having the ability to activate nutrients in the soil and fixate heavy metals. Most used are the matters based on zeolite - tuff combined with other natural additives. The market offers a number of such products.
- Biological production often uses silica flour.
- The theoretical base for the application of the above mentioned matters, in a way, represents a slow-down and reversion of pedoevolution to the previous stages.

The measures for managing soil biological properties are as follows:

- Irreplaceable advantage relative to all other materials is given to the vermicompost (worm compost) which best ensures the favorable preservation of a rich microbiological life and whose content and condition in the soil serve as indicators in the evaluation of soil nursing and its suitability for sustainable production.
- For the purpose of having a well balanced supply of nitrogen (N), allowed is the bacterization of legumes with the *Rhizobium bacteria*. This process is called inoculation.

- There is an ongoing work on the production of microbiological cultures for composting (faster humification), as well as studying and production of mycorrhiza fungi for as many crops as possible.
- Other types of microbiological fertilizers bacteria that decompose silica and release nutrients, phosphorous bacteria or preparations with several types of organisms with universal effects on soil biology are in expansion too.
- The treatment of soil with microbiological cultures makes sense only if the other conditions in soil are met: pH reaction, nutrient supply, favorable water-air regime, otherwise, the introduced microorganisms will degrade.

Land Management Aimed at Adjustment to Climate Changes

The agricultural activities have an impact on changes in the environment, but the environmental changes influence the agriculture as well. The management of the soil organic matter deserves a particular attention due to its role in the soil ecological functions and the global carbon cycle. Since it increases the capacity for retaining water and heat, circulation of nutrients, improves the structure and protects the soil from erosion, but also because of its climate regulation role, the management of organic matter can increase the soil productivity as well as the quality of the environment.

To use the soil as a place for storing carbon, i.e. to use good agricultural practices to improve the soil fertility and mitigate the negative effects of human activities on carbon cycle (slow down the increase in the concentration of CO₂ in the atmosphere), represents one of the inevitable tasks of modern agriculture. Good understanding of the processes and factors that influence the quantity and forms of organic carbon is a precondition for the good management of the soil organic matter.

In order to achieve higher carbon stocks in soil, agricultural practice must:

1. increase the supply of C to the soil in the form of plant detritus (increase the net production of biomass) and
2. reduce the level of decomposition of soil organic matter (conservation practice).

The main processes of storing carbon in soil include humification of the organic matter, aggregation through the formation of organo-mineral complex, deep storage of the organic matter, below the tillage level, cultivation of plants with deep root systems, calcification.

GOOD MANAGEMENT PRACTICES IN AGRICULTURE

Good management practices represent individual practices, measures, techniques, procedures and principles of good management of human activities, or their combination. These practices are developed in order to achieve balance between the protection of the quality of environment and human activities while respecting the natural and economic constraints. The entire postulate is based upon the principle that daily agricultural activities should be performed in the environment friendly way since it is generally cheaper and more pragmatic than the subsequent interventions. In this sense, a good agricultural practice implies:

- implementation of reduced tillage, until the *no tillage* or biological soil tillage system is introduced,
- contour cultivation and sowing in strips as well as terracing on slopes,
- controlled drainage and irrigation,
- agroecological zoning and selection of optimal type of land use,
- effort to keep the soil continuously covered with vegetation by:
 - using temporary protection (cover) crops,
 - sowing over the crop residues,
 - avoiding the fallowing of agricultural areas (leaving the land without crops),
 - mulching (covering) the soil areas by plant residues, gravel and stone, synthetic materials and the like
- maintenance of the level of organic matter and humus in the soil by incorporating the crop residues,

- rotation of crops which ensures diversity of niches and resources that stimulate the soil biodiversity is considered to be the corner stone of sustainable agriculture as it acts like a tool for pest and soil fertility control. Crop rotation implies the cultivation of several crops on the same field but in turns, in a combination of tall and short crops. The introduction of legumes and clover-grass mixtures into the crop rotation is mandatory,
- conversion of the way of land use into perennial grasses and forest vegetation sometimes may be the only solution to the problem of nutrient pollution from agriculture and
- reduce unnecessary trampling by agricultural machinery.

Good Agricultural Practices in the Application of Mineral and Organic Fertilizers

Most agricultural crops require large quantities of plant nutrients, i.e. more than it is available in the soil, so it is necessary to bring in some from the external sources, namely to apply the mineral and organic fertilizers. The optimal use of fertilizers for a specific type of agricultural crop is the most important element of the proper application of nutrients. The ultimate goal is to provide enough accessible nutrients meeting the plant's requirement during its growth while minimizing potential losses into the environment. The optimal fertilization returns the soil the same quantity of nutrients that were taken out by harvesting. There is a general rule that the achievement of high yields and good quality should be realized through the application of a well-balanced and sufficient quantity of both mineral and organic fertilizers. The application of fertilizers should correspond with the plants' requirement for nutrients and the status of optimal soil fertility with minimum pollution of the environment.

Organic Fertilizers

Production and use of organic fertilizers in the agricultural practice is considerable. In our country, these are mainly the manure from farms, liquid manure, urine, guano manure and compost. The quantity of added manure should be based on the content of nutrients in it. The total quantity of nitrogen added as manure, liquid manure or urine cannot exceed the annual quantity of 170 kg/ha.

The manure, liquid manure and urine should be applied when the level of nutrient efficiency in plants is highest, otherwise losses are huge and consequences for the environment adverse. Because of this, manure should be spread over the land parcel at the time which coincides with the maximum plants' requirement (not to be applied between October 15 and March 15). A uniform distribution of manure should be ensured, and in-ploughing should occur as soon as possible after the distribution of manure (5 hours). Manure should never be applied in proximity of the watercourses (not less than 10 m) and slopes inclination exceeding 10°.

The manure is stored in specially built facilities (basins, lagoons), sites fenced by embankments or dug holes. This is often a considerable additional expense for the farmers. These facilities are best built on impermeable soils, such as clay, or by placing the geotextile which will reduce the possibility of leaching and groundwater pollution.

Mineral Fertilizers

Improper application (type, doses and time of application unadjusted to the crop requirements) of mineral fertilizers causes undesired effects on soil, water and plants, i.e. environment in general. It should be noted once again that the natural phosphates, potassium minerals, natural gas and energy used in the production of mineral fertilizers are non-renewable natural resources, and their reserves on the planet are limited. The application of the proper type of fertilizer is essential in a given situation. It gives us the opportunity to achieve the maximum positive result with minimum adverse effects.

Also, keeping and storing of mineral fertilizers require special regulations, instructions and conditions aimed at preserving their chemical and physical composition, as well as their eventual negative effect on the environment. An important rule is to keep the fertilizers in their original package and under the conditions required by the provision on their storage.

Determining the mineral fertilizer dosage is a very serious and complex task. The application of insufficient quantities results in low yields, whereas excessive doses may cause unwanted effects on environment (pollution), their accumulation in the plants, deterioration of products' quality, etc. Because of this, it is very important to conduct occasional control of the soil fertility in order to be able to determine the fertilizer dosage in a proper way.

The mobilization of introduced plant accessible nutrients is a precondition for high yield. A surplus of, for example, nitrogen that is not out taken by the plants easily evaporates from the root zone. Therefore, it is important that total nitrogen adds to the plants on several occasions through the so called side or top-dressing.

The analysis of the status of nutrients in plants may be useful in terms of adjusting the fixed doses of fertilizers and timing, depending on the level of supply of plant nutrients and their accessibility. The requirement for plant nutrients is determined based on the calculation of the quantity taken in by the plants in the planned yield.

The soil analysis and professional interpretation are important information related to the capacity of soil to provide nutrients to the plants. Some special charts with estimated outtake of nutrients through plants are used for this purpose. For such calculations, it is very important to make a realistic assessment of the expected yield since it may be influenced by many other factors too. Some of these factors are hard to predict, e.g. weather conditions.

The application of organic and mineral fertilization should facilitate the improvement of both the yield and its quality. Their application must not induce accumulation of compounds harmful for human and animal health. The balance of plant nutrients (N, P, K, Ca, Mg, etc.) shows their input and output on a certain area, plot, farm or region. It is useful to evaluate the migration of plant nutrients in a fixed period, e.g. one year. The usual levels should be 100-120 % for nitrogen or 120-150 % if the yield is above 5 t/ha (grain units). The risk from pollution increases if the above cited levels are exceeded. Balance recommended for phosphorus could be 160-200 %, for potassium 120-150 %, depending on their content in the soil. Farmers should try to achieve the balance that is less or normal for a specific farm under the given conditions.

There is a requirement to limit the period between the application of soluble mineral fertilizers and the time of plant's most intensive nutrient uptake. The spring-time is therefore strongly recommended as the most optimal timeframe for most plants. The objective is to reduce the eventual risk from the nutrients being leached or transformed into less accessible forms. The application of fertilizers is strictly forbidden under the following conditions:

- if the soil is frozen or covered by snow,
- if there is a risk that the field with applied fertilizer could be flooded and
- if the water saturation of soil indicates the possibility of filtration.

The agriculture is present even in some very sensitive and environmentally vulnerable areas. The specific measures need to be undertaken while applying fertilizers in vulnerable and highly risky areas or conditions, in order to prevent migration of nutrients into the water. The risky areas are as follows:

- Rolling (sloping) topography: fertilizers should be incorporated in soil right after the application, except for areas with well-developed vegetation.
- Areas that may be flooded during a part of the year: fertilizers may be applied only out of the flooding season.
- Areas where the ground water reaches the surface of the ground: fertilizers may be added only when the level of ground water is low and the land parcel dry.
- Area bordering with water: use of fertilizers is not allowed in the shore area of rivers, canals, lakes, accumulations and water intakes. The cleaning of the fertilizer spreading equipment is also banned in such areas. The surface waters and organisms living in them are very sensitive, even to a small quantity of fertilizer. Application of fertilizer is banned in the zone closer than 10 m from the shore.
- Sandy soils with low content of organic matter and acidic as well: in this case small doses are recommended, and a total amount of fertilizers should be divided into several portions.

Some fertilizers, especially the liquid ones, may be used as a mixture with herbicides and fungicides. If the protection chemicals (pesticides) are included in the system of fertilization, the overall regulation for pesticides has to be complied with.

The fertilizer application technology comprises several important steps: organization, selection of machines and equipment, their calibration, quality control. The commercial farmers applying fertilizers on more than 10 ha should develop an annual plan of fertilization and history of the parcels.

The major factors that need to be taken into consideration while developing the plan of fertilization include:

- type of cultivated crops and targeted yield level,
- relief related conditions (terrain, type of soil, texture, status of plant nutrients in the soil, water-air regime of the soil),
- climatic conditions,

- land use methods, agro-technique applied, intensity of production, crop rotation,
- other sources of plant nutrients, and their representation (manure, green manuring, straw, legumes),
- fertilizers that are more suitable for specific requirements and their cost and
- equipment and agricultural machinery available on the farm.

To achieve the best results it is recommended that the plans of fertilization on the farms be developed by experienced professionals, i.e. agronomists. This is an important document in the agricultural as well as the ecological aspect.

It is important to make sure that the practical advice as to how to develop the *best (good) agricultural practices* are flexible and pragmatic with regard to the inclusion of new technologies as well as those more traditional technologies for the conservation of nutrients in the soil.

Regardless of the fact that the level of the mineral fertilizers and manure applied per area unit of agricultural land in Bosnia and Herzegovina is rather low (compared to the EU countries) one should take a serious risk from diffuse pollution that may be caused by improper application of mineral and organic fertilizers. The national strategic planning pertaining to the control of pollution by nutrients coming from agriculture requires development of proper tools and institutional arrangements for the promotion of adequate application of mineral and organic fertilizers, as well as the best agricultural practices available.

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Quality of environment in the area of Lijevče polje has been exposed to ever more and stronger environmental factors, especially the anthropogenic ones (Nedović et. al., 2003). Concentration of heavy metals (Pb, Hg, Cd and Cu) and pesticides (atrazine) poses a serious concern. Level of heavy metals in soil and ground water is low (below MAC). Among heavy metals the highest concentrations are found in copper (7,46 mg/kg). Atrazine level is below MAC, though its concentration in soil is higher (0,13 mg/kg) on the areas where maize is grown as monocrop, while its level in ground water is rather low which means that there was no leaching.

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THE BASIC PRINCIPLES OF FARM WASTE MANAGEMENT

The main task of any natural ecosystem, including the agro-ecosystem of rural areas too, is to be dynamic, cyclic, self-regulating and sustainable. From the aspect of agro-ecosystem, waste is represented in all its forms:

- Liquid – liquid manure, sewage waters, effluent from stables, from farms, etc. The EU *Nitrates Directive* strictly prescribes the ways for keeping and managing the manure (construction of reservoirs or lagoons for liquid manure is mandatory, etc.),
- Solid – organic detritus of various plants (crops and weeds), food residues, dead animals' detritus, defective agricultural machines, their parts, etc. Organic waste should be used for making compost – a specific type of organic fertilizer,
- Gaseous – mainly dust, carbon dioxide, methane, nitrogen oxides and, depending on whether the protection chemicals are used or not, maybe some additional complex compounds in gaseous state. For the purpose of air protection, the agriculture should look at the ways for reducing the combustion of organic detritus, migration of particles from bare soil, emission of pesticide aerosols into the atmosphere. The employment of the so-called conservation tillage of soil will reduce the emission of greenhouse gases induced by agricultural activities.

The management of some types of waste in rural areas may be properly resolved on the spot (on the very location of their origin) by applying the environment friendly methods and so-called *green technologies* (e.g. application of filtering plants such as rush, reed, plantains, which are characteristic for our rural areas).

The pollution source control measures are aimed at reducing the pollution by acting on its very source. Such measures are mainly directed toward reducing the accumulation of pollution on impermeable surfaces of the subject catchment area; reducing the erosion from permeable soils; and, applying modern farming practices. The efficient and effective implementation of the source control practices requires an extensive education and more effort of the general public.

6. LOCAL BENEFITS FROM THE SUSTAINABLE MANAGEMENT OF AN ECOSYSTEM

Agriculture largely represents a basic activity and the largest source of income to the rural population. It is the corner stone as well as the engine of development of the rural areas. The agricultural production is labor intensive and requires considerable financial resources, but in return it can expect nothing more than unreliable yield and uncertain marketing of the products. From the historic point of view, it can be stated that in almost any society, and particularly during the process of industrialization of the human society, it was permanently neglected and belittled as a less worthy occupation. Farmers all over the world have been put in a position where they have to produce continuously cheap food or inputs for the food industry and other types of industry alike. Simply said, cheap food is the corner stone of the social and economic stability of the overall society, and farmers carry the most part of this burden on their shoulders.

The EU countries, though it is a common practice in most countries, use subsidies to encourage the producers to increase their production. The objective of any country is to produce their own food in the sense of supply security, as well as to at least partially correct this unjust distribution of resources. However, we are witnessing the existence of constraining regulations aimed at preventing the production of

surpluses due to high storage costs. This was the reason for the introduction of quotas – prescribed amounts of certain products harmonized with the market demands, or even paying subsidies for leaving the land uncultivated, i.e. unsowed. Concurrently, the world market is loaded down by cheap food coming from the countries having specialized monocrop production. The regulations on limited use of certain varieties, ban on the application of liquid manure, green taxes, reduced application of agro-chemicals, mandatory construction of slurry ponds and lagoons, etc, are just some of the measures being implemented in order to preserve the environment and which ultimately require ever bigger initial investments by farmers and make the production very expensive. Recently, there are some suggestions to even cut the agricultural subsidies as a saving measure leading to the recovery from the economic crisis. It is a fact that the number of active farmers in the EU countries has decreased by 35% in the past 15 years, i.e. by 70% in the past fifty years, so that they make up only 6% of the total population.

For the sake of people's survival in rural areas, and for the sake of their development, it is necessary to diversify jobs in rural communities. Agriculture cannot or should not be the only source of income for the rural population.

RURAL DEVELOPMENT AND EU

In the EU there are currently two agricultural funds that support rural development programs – the European Agricultural Guarantee Fund (EAGF) which finances the market measures, and the European Agricultural Fund for Rural Development (EAFRD) set up for the financing of rural development programs. The financial resources are also used to support the following activities: professional events, congresses, symposiums, seminars, fairs, as well as projects harmonized with the policy on fiscal support for primary agricultural production.

The support to rural development is realized through the measures within the three axes defined by EU CAP (2007 - 2013):

1. Axis: Building competitiveness of agricultural produce – increase of the farm area (by at least 0.3 ha in 2007), and their modernization (buildings, processing plants, livestock, seeds, planting material, equipment and mechanization);
2. Axis: Protecting rural environment – a multitude of measures that contribute to the viability of rural areas and establishment of the organic farming; and

3. Axis: Diversifying economy and preserving the heritage – support for the specific job diversification projects aimed at increasing the income sources; support for the projects that contribute to the protection of natural and cultural heritage and projects that support preservation of autochthonous plant and animal species.

DIVERSIFICATION OF ACTIVITIES IN RURAL AREA

The main source of income for rural population is related to agricultural activities. Depending on agro-ecological characteristics, we distinguish several types of rural areas, such as:

- rural areas producing fruit and vegetable,
- rural areas producing industrial crops,
- rural areas breeding large animal (stable type of breeding),
- hilly-mountainous rural areas for pasture and animal farming,
- hilly-mountainous rural areas producing forestland and medicinal plants,
- hilly-mountainous rural settlements dealing with tourism and recreation,
- rural areas on the river banks and lake shores involved in fishery and
- suburban areas, etc.

The rural areas (especially those in the hilly-mountainous regions) can be made very attractive by combining various production activities. In addition to food production, many of them may develop some supplementary activities as a source of income. Diversification of economic activities in rural areas implies any income generating activity other than agriculture. The benefits of diversification of rural economy for the rural population are manifold. In this way young farmers get a chance to create a new perspective for their work and living in their home settlements.



Picture 12. Rural area (Čemerno near Gacko)

The activities that can be organized for this purpose are numerous:

- Collecting and processing of forest fruits,
- Collecting and processing of medicinal plants,
- Manufacturing of various handmade products (knitting, sewing, pottery, products made of leather, wood, metal, etc.),
- Manufacturing and finishing of various elements and industrial production (pottery, fretwork, blacksmithing, etc.),
- Assembling of certain products and industrial devices,
- Tourism (hiking, skiing, open type zoos, outings to forests, mountains, lakes),
- Catering and gastronomic services with the prevalence of domestic food products: eco products, home-made brandies *šljivovica* (plum brandy), *kruška* (pear strong drinks) and *loza* (brandy), numerous kinds of home-made jams, marmalades and syrups made of apple, pear and plum, home-made *ajvar* (chutney), meat preparations (smoked meat, sujuk),

- Sports (cross-country races, cycling, extreme sports, traditional sports, stone tossing, dances, etc.),
- Spa, sanatoriums, resorts, etc.

BIODIVERSITY AS A DEVELOPMENTAL ADVANTAGE OF RURAL AREAS

The biological diversity is a fundamental component of the environment as well as the best and most reliable indicator of the state, trends and potential development abilities of any area. According to Raven (1993), biodiversity is a collection of the world's types of plants, animals, mushrooms and microorganisms; genetic variation within these organisms, communities and ecosystems. According to Ehrlich and Ehrlich, (1992), biodiversity is a diversity of biologically distant populations and types of plants, animals and microorganisms with which the Homo Sapiens constitutes the ecosystem diversity, whose functional parts they all are.

Nowadays, the biodiversity is adopted as an international term that indicates the species richness (plants, animals, microorganisms) in an interaction relation in a given area. The major components of biodiversity include genes (genetic diversity), species (diversity of species) and ecosystem (ecosystem diversity). Biodiversity is very important for the functioning of biosphere and all the ecosystems, as well as the regulation of climate. Additionally, survival and development of the human population would be impossible without biodiversity.

The rural areas can still be considered as rich reservations of various plants, animals and mushrooms, which provide them with a comparative advantage relative to other areas, especially the urban ones.

Bosnia and Herzegovina is classified as an area with the highest degree of biological diversity in Europe. Based on the current inventories, richness of the animal life in Bosnia and Herzegovina is exceptionally big in comparison with the richness of species in corresponding groups across the Balkan peninsula, and represents a valuable national asset and exceptional developmental potential. Some of the plant or animal species have become so much naturalized and adapted that in combination with the wildlife they represent a valuable portion of the natural heritage of Bosnia and Herzegovina. The BH Report for the 2002 World Summit on Sustainable Development (WSSD) reads that Bosnia and Herzegovina has a high level of biological diversity that is seriously endangered. Therefore, the biological diversity, being one of the most significant indicators, should be saved for the future generations through the implementation of systemic measures of sustainable development.

DIVERSITY OF THE FOREST ECOSYSTEMS

Diversity of the forest ecosystems is represented by diverse deciduous and coniferous forests, such as oak, beech, hornbeam, pine, fir, juniper or mixed forests. The areas of forest ecosystems are usually located on the soils of lower rating class, characterized by sloped terrain, erosion processes and hardly accessible parts. However, these characteristics may also be one of the developmental advantages when it comes to the possibility of developing various types of sport activities such as hiking, or various types of winter and extreme sports (skiing and snowboarding, bobsledding, cycling, paragliding, cliff diving, etc.).

In addition, the forest ecosystems have various forms of bushy vegetation (blackthorn, hawthorn, hazel, cornel, blackberry, and hop) that are particularly significant in terms of medicinal properties and healthy source of food. For example, various types of forest fruit are found in the meadow-pasture parts of rural areas: *Rosa canina* (dog rose), *Cornus mas* (European cornel), *Crataegus oxyacantha* (evergreen thorn), *Punica granatum* (pomegranate), *Crataegus jacq* (common hawthorn), *Prunus spinosa* (blackthorn), *Sorbus torminalis* (checker's tree), etc. All these species are well known, and much required in Europe and beyond as they are recommended to a specific population category – diabetics, for regulating the sugar level in blood. The forest ecosystems characterize various forms of mushrooms many of which are used in nutrition, medicine, scientific researches and education.



Picture 13: Dog rose (*Rosa canina*)



Picture 14: Sorbus torminalis (checker's tree)

Diversity of Agro-Ecosystem

Within the diversity of agro-ecosystem, one of its specific elements is related to the genetic resources – plant and animal species having direct application in human life, production of food, medicines and materials, in horticulture, ecologic and genetic engineering and biotechnology. They currently include various domesticated plants, such as fruit, vegetables, grains, ornamental plants and domestic animals.

The diversity of agro-ecosystems in our climate zone is reflected in a large number of fruit varieties:

- plum (*Stanley, Požegača, Čačanska rodna, Čačanska ljepotica, Bilka rana/ Quatsche de Bühle, California blue*),
- apple (*Idared, Jonagold, Golden Delicious, Melrose, Elstar, Gloster, Granny Smith, Topaz*,
- pear (*Williams, Beurré Bosc, Butira precoce Morettini, Santa Maria, Passe Crassane, Cure, Champion, Abbé Fetel, June Beauty, Citronka/Kieffer Seedling*)

- strawberry (*Toplička jagoda, Miss, Maya, Marmolada, Pocahontas, Zenga zengana, Chandler, Belruby, Selena, etc.*),
- raspberry (*Meeker, Willamette, etc.*)
- blackberry (*Jambo, Thornfree, etc.*),
- cherry (*Burlat, Đurđevka, Bing, Stela, Hedelfinger*),
- sour cherry (*Oblachinska, Rexel, Heimann, etc.*),
- peach (*Redhaven and Firehaven, Collins, I. H. Halee, Red Top, Dixired*),
- apricot (*Mađarska/Hungarian, Kecskemet Rose, Nugget, domestic cultivars*),

In this area several prominent grapevine cultivars are cultivated, such as Žilavka, Blatina and Plavka. As for the forage crops, traditionally most grown are alfalfa, red clover, vetch, orchard grasses, stock pea, etc.

Results of the work group for forage crops within the SEEDNet Project (Gatarić et.al., 2010) are reflected in storing the accessions that are very important for the preservation of genetic resources, breeding aimed at creation of new cultivars and other scientific purposes. In the future it is necessary to continue with inventorying and multiplication, and to initiate activities on characterization, evaluation and elaboration of descriptors for the stored accessions. During the researched period from 2004 to 2009 an inventory was carried out and 157 accessions of forage crops represented by 22 species from 13 genera were stored in the Banjaluka plant gene bank. The collected and stored accessions are just a part of the genetic resources of this area; the research should be extended to a much larger number of species and habitats, while paying special attention to the species of the following genera: Trifolium, Medicago, Lotus, Lolium, Festuca, etc.

The ornamental flora, also represented in many farm yards, includes rose, heartsease, begonias, chrysanthemum, cyclamen, etc.

A research of the adventive weed flora in Bosnia and Herzegovina present in crops and perennial plantations has identified 19 species: Amaranthus albus L., Amaranthus retroflexus L., Ambrosia artemisiifolia L., Asclepias syriaca L., Avena barbata Pott. ex Link., Bidens bipinnata L., Conyza canadensis (L.) Cronq., Erigeron annuus (L.) Pers., Foeniculum vulgare Mill., Galinsoga parviflora Cav., Lathyrus sativus L., Medicago sativa L., Oxalis stricta L., Portulaca oleracea L., Sorghum halepense (L.) Pers., Veronica persica Poir., Xanthium italicum Moretti,

Xanthium spinosum L. and Xanthium strumarium L. which are very common cenobionts in weed and ruderal vegetation (Kovačević et al., 2008).

The problem of ragweed (Ambrosia artemisiifolia L.) being an invasive species spread throughout in Bosnia and Herzegovina was comprehensively addressed by a group of authors (Trkulja et al., 2009) in their publication discussing the problems it causes in rural areas, in agriculture, its control and especially the problems related to human health as it is a very dangerous allergen plant that is increasingly expanding in our environment.

Autochthonous Species

The biodiversity of rural areas is distinguished by the abundance of autochthonous and acclimatized plant species and animal breeds. Some rural areas are often home to very rare endemic plant species and animal breeds which can make them recognizable and unique in comparison with other areas.

The autochthonous varieties and breeds constitute a significant part of biological diversity as it is stated by the *Convention on Biological Diversity*. Autochthonous indicates the authenticity of origin – originality and represents any plant or animal species for which it is possible to paleontologically prove that they have always existed in a given area, i.e. that they have not been introduced from somewhere else (allochthonous species).

The genetic biodiversity of autochthonous varieties and breeds plays an important role in improving the quality of foodstuffs and veterinary practices since such types are more resistant to many pathogens. When the preservation of genetic diversity in EU and the world is concerned, the highest priority should be given to the preservation of the autochthonous varieties of grains, legumes, fruit and vegetables.

The breeds and varieties in natural environment are related to certain areal (areas of distribution), climate or human activities. Human activities in agriculture, to include the process of selection/breeding in animals, poultry, fruit, vegetables and grains, lead to the reduction of genetic biodiversity of the cultivated/bred population. Each breed is a source of genetic diversity that pertains to the frequency of specific genes, which make that specific breed resistant and adapted in its survival efforts.

Table 5: Autochthonous breeds of domestic animals in Bosnia and Herzegovina (Rahmanović et al., 2009.)

Types	Domesticated breeds	BH breeds
Horse <i>Equus caballus</i> L., 1758;	<i>E. ferus</i> Boddaert, 1785 (<i>E. f. przewalskii</i> , <i>E. f. gmelini</i>) and their crossbreds	Bosnian–Herzegovinian Mountain pony
Cow <i>Bos taurus domesticus</i> L., 1758;	<i>B. primigenius</i> Bojanus, 1827 (<i>B. Primigenius taurus</i>) and their crossbreds	Buša Gatačko
Sheep <i>Ovis aries</i> L., 1758 (<i>O. a. domestica</i> = <i>O. ovis</i>);	<i>O. orientalis</i> , <i>O. musimon</i> , <i>O. vignei</i> and their possible crossbreds	Pramenka
Goat <i>Capra hircus</i> L., 1758;	<i>C. h. domestica</i>	Native Balkan's antlered
Dog <i>Canis familiaris</i> L., 1758 (<i>C. canis</i> = <i>C. Domnsticus</i> = <i>C. lupus familiaris</i> = <i>C. l. domestica</i>)		Bosnian – Herzegovinian pastoral dog <i>tornjak</i>
Pig <i>Sus scrofa</i> L., 1758;	<i>S. s. domestica</i> (= <i>S. domesticus</i>)	Šiška
Pigeon <i>Columba livia</i> L., 1758;	<i>C. l. domestica</i>	Travnik short beaked, Bihać roller Sarajevo roller Zenica roller

The Bosnian mountain pony descends from *E. Przewalski* and *E. Tarpan*. Two types - *Glasinački* and *Podveleški*, have developed in Bosnia. The *Glasinački* type has a larger frame and a higher participation of the Arabian horse blood, while the *Podveleški* type has smaller frame and less Arabian breed influence. The Bosnian mountain horse is a late mature breed.

The Bosnian buša/busha belongs to the group of short-horned cattle. It is small in size, and its body weight ranges between 150 and 300 kg. The average milk production ranges between 800 and 1,200 liters per year, with the average of 3.7 % milk fat. „Buša/Busha“ is autochthonous to the Balkans region and some hundred years ago it was the predominant breed. Nowadays this breed in Bosnia and Herzegovina is critically endangered and almost forgotten. Buša has distinctive characteristics that include: gray-brown color, bog horns, height approximately up to 110 cm and weight around 200 kg. It is very resistant to diseases and extreme climate conditions (temperature, precipitation, air pressure),

hence very suitable for ecologic animal husbandry and open-range grazing. It has well-developed adaptation ability in terms of surviving in the open natural habitats throughout the year. It provides milk, cheese and meat of high quality. Buša plays an important role in the rehabilitation of traditional landscapes with predominant meadows and pastures which, unless used for grazing, relatively quickly get overgrown. Revitalization of Buša and the possibility of developing ecologic animal farming and rural tourism, provide a good basis for economic development of thinly populated mountainous settlements.



Picture 15. Buša/Busha, autochthonous breed of the Balkans

Pramenka is a primitive sheep breed raised extensively. There are a few types of this breed in Bosnia and Herzegovina: Dubska or Vlašička, Kupreška, Hercegovačka, Varcarska and Privorska.



Picture 16. Herzegovina's breed of pramenka

Bosnian-Herzegovinian multicolored horned goat belongs to a group of Balkan primitive goats. It descends from the wild original types: C. prisca, C. aegagrus, C. falconeri. The average annual milk output in our domestic goat is 100 - 130 liters.

Tornjak belongs to a group of non-hunting dogs, the sub-group of shepherd dogs, whose population is slowly increasing. Tornjak is a breed of shepherd dogs spread in the region of Bosnia and Herzegovina and Croatia. As autochthonous breed, Tornjak was registered on 9 May 1981, under the name „Bosnian-Herzegovinian shepherd dog – tornjak“, and in 2007, renamed into „Bosnian-Herzegovinian-Croatian shepherd dog – tornjak“. It is included in the FCI under the number 355.



Picture 17: Bosnian-Herzegovinian sheepdog - tornjak

The Bosnian sharp hair "Barak", thanks to its working and hunting abilities, is a persistent dog suitable for hunting under hard conditions.

The autochthonous fish breeds include:

- *The Neretva softmouth trout, endemic salmonidae found in the Neretva River. Lives in shoals. It feeds on zoobenthos, mainly insect larvae, but some other floor organisms as well. It reaches up to 25 - 40 cm in length and maximum 2 kg in weight.*
- *Glavatica (marble trout) is the largest salmonidae type in the Mediterranean region and is endemic to the Adriatic basin. It can reach up to 140 cm in length and up to 30 kg in weight. It is a predatory breed feeding mainly on smaller fish (piscivore).*

Table 6: Autochthonous game sub-species in BiH

Species	Sub-species
Deer <i>Capreolus capreolus</i> (L.)	<i>C. c. grandis</i>
Chamois <i>Rupicapra rupicapra</i> (L.)	<i>R. r. balcanica</i>
Wild boar <i>Sus scrofa</i> (L.)	<i>S. s. reiseri</i>
Wolf <i>Canis lupus</i> (L.)	<i>C. l. kurjak</i>
Beech Marten (Samsar) <i>Martes foina</i> (Erleben)	<i>M. f. bosniaca</i>
Brown bear <i>Ursus arctos</i> (L.)	<i>U. a. bosniensis</i>

Organic Farming

From the beginning of the new millennium, organic farming has become a vitally important topic as it practically protects people's health, as well as both producers and consumers who buy and consume organic food. Producers of organic food are in it because of higher prices and safer marketing while the consumers' reasons are primarily health related. The intensive (conventional) agriculture and organic agriculture as its positive critics should develop a relationship rather than conflict, as that would result in producing sufficient quantities of quality organic food. The authors state in the paper all the advantages and challenges of the production of organic food in Bosnia and Herzegovina (Nedović et al., 2002).

The organic farming in Bosnia and Herzegovina, being one of the ways for preserving biodiversity in rural areas, as well as a development opportunity in terms of diversification of agricultural products, is still not represented to the extent it should be. In addition, the native plant and animal types are not receiving enough attention. At the same time, the introduced species have a predominant role in the agricultural sector, which increases a chance for the infiltration of some new parasites, invasive species, as well as numerous other pathogens.

The organic products are a result of the farmers' awareness about the significance of healthy food and renewal of natural resources. They are obtained by taking advantage of the strengths and capacities of the agro-ecosystems, by stimulating and harmonizing biological processes, without using chemical substances (mineral fertilizers, pesticides, hormones, insecticides) or GMO.

In 2005, the area used by organic farming in the EU was 3.9% of total agricultural area in the EU; approximately 1.6% agricultural farms are so-called organic farms, with an average area of 39 ha. The largest percentage of organic food production relative to total agricultural area is recorded in Austria (11,0%), Italy (8,4%), Czech Republic and Greece (7,2%), Malta (0,1%), Poland (0,6%) and Ireland (0,8%).

The organic food has a continuously growing tendency on the world and European markets. The European and North American markets are the largest organic food markets in the world. The total sale of organic product in Europe reached the amount of USD 14.4 billion in 2005.

Currently in Bosnia and Herzegovina there is no entity or State-level laws on the production of organic food. In practice, the organic production in Bosnia and Herzegovina is performed in a disorganized and uncoordinated way. According to the ECON data (Foundation focused on development of sustainable employment in Bosnia and Herzegovina), in 2004 around 1,180 ha of land were certified for this type of production on the territory of Bosnia and Herzegovina. In the organic production domain, the non-government sector has established a network of producers, inspection and certification body, a certification agency („Organic control“) and developed the organic product logo („OK“ mark for organic control by certification agency).

Some of the attractive ecologic farming activities occurring in rural areas include ecologic beekeeping, ecologic fruit and grapevine growing, ecologic animal breeding, etc.

Organic beekeeping represents an activity where man, plant and animal form a symbiotic relationship. The honeybees pollinate over 80% various plants, fruits and vegetables (apple, potato, broccoli, strawberry, raspberry, etc.) making thus a typical example of a beneficial relationship between different species – symbiotic mutualism. This type of rural activity has a huge potential when it comes to the production of high-quality products, such as honey, honey-comb and many other medicinal honey-based preparations. In addition to being quality products, they also may be autochthonous and as such appreciated at the European and world markets. There are several types of honey formed depending on the predominance of a specific plant species, so that we have the ecologically produced honey from various aromatic, medicinal and forest plants, as well as trees. Some of the famous types of honey produced in rural areas of Bosnia and Herzegovina are as follows: sage honey (*Salvia officinalis*), lavender honey (*Lavandula sp.*), rosemary honey (*Rosmarinus officinalis*), chestnut honey (*Castanea sativa*), acacia honey (*Robinia pseudoacacia*), linden honey (*Tilia*), etc.



Picture 18: Various handmade ecologic bee-hives in the National Park "Una"

Organic olive-groves – Olive, a Mediterranean fruit belongs to the family of *Oleaceae*. It is commonly known as a *rich tree of poor soils*. Olive tree easily adapts to the specific climate and soil conditions of xerothermic habitats, develops deep roots depending on the habitat quality. This is a slow-growing tree, and it often takes more than 15 years to become fully fecund. Its life span is long (around 150 + years). It is often heard that in the Garden of Eden there were two trees: fig and olive. Fig is the Tree of truth while olive is the Tree of life. There is also a famous Latin thought about the olive tree: "*Oles prima arborum omnium est*" – "Olive tree is the first among all the trees".

The farthest southern and south-western parts of Bosnia and Herzegovina have a long tradition in olive growing and producing the olive oil. It is believed that the beginnings of the olive growing in Herzegovina are related to Ali pasha Rizvanbegović, who was a pioneer in the popularization of olive growing in this region. The well-known plantation along the Mostar – Čapljina – Stolac road used to be a biological landmark until the past war. Today, there is a village named after the olive tree "Masline". At the present time, there are very few olive groves in Bosnia and Herzegovina relative to the natural capacities of the south-western rural areas in the vicinity of Mostar, Neum, Stolac, Čapljina, etc. Due to various circumstances, such as war activities, fire, migration to urban areas, etc., many Herzegovinian olive groves are abandoned and uncultivated.

The olive fruit is processed in specialized oil mills in order to produce very healthy olive oil. In their diet people mostly use olive oil and fruit. Additionally, olive is used in medical and cosmetic industries.

Since the olive groves are very significant in terms of the production of food, medicines, cosmetics, rural handicrafts (wood made souvenirs), they may be a considerable source of income to young olive growers and processors in the rural areas of Herzegovina. In addition, this type of agricultural activity may have positive effects on the reduction of emigration to the urban areas. In order to make the olive-groves biologically sustainable, it is recommended to plant proper autochthonous plants or fruits (almond, fig, rosemary, lavender, etc.) outside and inside the olive groves (almond, fig, rosemary, lavender, etc.).

Organic viticulture – According to the data made available by the United Nations Food and Agriculture Organization (FAO), Bosnia and Herzegovina is placed at the very bottom position of the world and European lists of wine producers. The Bosnia and Herzegovina's vineyards make up only 0.1% of the total world vineyard area. By the vineyard area it is on the 63rd position out of a total of 89 world countries involved in viticulture.

The southern parts of Bosnia and Herzegovina with Mediterranean climate and modest soils (Neum, Stolac, Trebinje, Popovo polje, Čapljina, Čitluk, Posušje, Grude, Široki Brijeg, Mostar and Ravno) have a large natural potential for development of viticulture. The types of grapevine suitable for dry and sandy soils are the best option for planting, growing and producing grapes and grape-based products. Grapevine can be planted on numerous abandoned Herzegovinian karstic areas in the way that rocks are first picked out, crushed and then arranged in stone fences. Prior to the war in Bosnia and Herzegovina, vineyards were planted on a total area of approximately 5,781 ha, of which 5,691 ha or 98.40 % belonged to the grape-growing region „Herzegovina“. The grape-growing areas in Herzegovina are located on both privately and publicly owned land (Table).

In Herzegovina the grape-growing can be a good foundation for the development of agriculture on one, and a factor in improving the standard of living on the other side, since the grape based products are in large demand and are well paid for at the market. Every country that grape is grown in, has its own autochthonous-domestic assortment, as well as a certain number of varieties introduced from other countries.

In Bosnia and Herzegovina, the most common local varieties include Žilavka (white), Blatina and Plavka, while those introduced from abroad include Pinot Noir, Gamay, Merlot, Smederevka, Italian Riesling, Semillon, Cardinal, Vineyard's Queen, etc. The grape based products may include: wine, liqueur, raisin, juice, jam, etc. Among the autochthonous grape varieties the most renowned ones are "Blatina" and "Žilavka", and among the grape-based products, it is certainly the Herzegovinian grape brandy „lozovača“.

PROMOTION OF TRADITIONAL KNOWLEDGE AND VALUES

Traditional knowledge and skills typical for a region or country need to be protected, developed and promoted based on the European, already proven positive experiences. Bosnia and Herzegovina is a traditionally rich country that was exposed to the impact of various culture and traditions through history (Pictures).



Kupres



Livanjsko polje



Jajce



Eastern Herzegovina



Čajniče and Foča



Bjelašnica



Čapljina



Eastern Bosnia



Jajce and Mostar



Sarajevo



Visoko



Brčko

Picture:19 Traditional folk costumes from different parts of Bosnia and Herzegovina

Ethno villages are currently the most attractive destinations in the tourist offer of rural areas. The prominent ethno villages in Bosnia and Herzegovina include: Etno - Begovo village in Bijambare, Herceg - Ethno village in Međugorje, Stanišići in Bjeljina, etc. Ethno villages are valuable places for the conservation of cultural values and customs of some region. They have various antiquities displayed (domestic objects, old tools, furniture, photographs); these are the places where one can get familiar with somewhat forgotten rural ambience, architecture, craft shops with tools and products, customs, culture, folk costumes, traditional dishes made of ecologically produced ingredients. In addition, these are the places with clean air that offer attractive excursion sites and untouched landscapes.

Many Bosnian-Herzegovinian valuable natural resources are preserved, such as the canyons of the Rakitnica and Krušnica, the bird reserves in Hutovo blato and Bardača, the primeval forest Perućica, the lakes Blidinje, Prokoško, Šatorsko and Boračko, the waterfalls of Kravica, Skakavac, Kozica, the Una River with its waterfalls, the upper Neretva, the wellspring of the Buna.



Picture 20: Ethno village in Bijambare

QUALITY “HEALTHY FOOD” IN RURAL AREAS

The relationship established between the typical traditional products and consumers is more complex than theoretic definitions and is expressed in various forms. From the consumers' point of view, the sense of belonging, originality and product knowledge, as well as the readiness to try something new, play a fundamental role in commitment of consumers. Consumption of typical products in some area highlights an ever growing awareness of the consumers about the role of rural communities and significance of their preservation and development; it increases sensitivity to the need to preserve and secure reproduction of natural resources. In the eyes of the consumers, in the absence of other information, the origin of the product is a strong sign of quality. Some surveys show that the origin of a product is the second most important information (price comes in the first place) for consumers.

There is a tough competition associated with the process of marketing various traditional products that are becoming increasingly appreciated in the global and European markets. One of the apparent effects of globalization is the situation where traditional products from certain parts of the world are plagiarized and launched to the market as original. This is why a quality education and promotion of knowledge about nutritive and protective properties of the products that are the inherent part of the culture and tradition of some region, becomes essential. A good knowledge and understanding of the adopted European regulations (directives, acts) governing the subject issues, is also required.

For example, by adopting the Regulations (EC) No. 2081/92 and 2082/92 in 1992, the European Union has begun establishing the system for the protection and valorization of the products having specific properties and characteristics that derive from the traditional way of their preparation, i.e. have the so-called traditional character. These regulations were replaced by the (EC) regulations No. 509/06 and 510/06 adopted in 2006, and (EC) regulations No. 1898/06 and 1216/07 that prescribe comprehensive rules for the implementation of the Regulations (EC) No. 509/06 and 510/06. These regulations made it possible for the farmers in the countries that are not EU members to initiate the procedure for protecting such products at their national authorities. This means that for example, products from Bosnia and Herzegovina could get labeled with the same indications as those coming from the member countries:

- *Traditional Speciality Guaranteed - TSG;*
- *Protected Designation of Origin PDO; and*
- *Protected Geographical Indication- PGI.*

„Traditional“ means a proven method of foodstuff manufacturing and/or processing passed down from generation to generation, over not less than a period which corresponds with one generation interval of 25 years. The traditional specialty guaranteed label, along with the others, is aimed at protecting the autochthonousness of agricultural products from various imitations as well as their disappearance.

„Speciality“ means that a property or multiple properties of one specific foodstuff make it clearly distinctive from other similar products of the same category. The property (properties) may pertain to physical, chemical, microbiological or organoleptic characteristics, the production method, or the conditions present during the production. A special presentation of a foodstuff is not considered a special property, especially its shape, appearance, package as well as the manner and place in which it is arranged and displayed.

The „Traditional Speciality“ indication emphasizes the traditional character in the product's composition, usually dishes in the gastronomic offer, as well as verifies the acknowledgement of the food's special properties. It comprises the name of a traditional foodstuff stating its specialties related to traditionalism. It may be awarded to the products specific by their composition or way of production, where the products are traditional in a specific area which means that their recipe is „passed down with generations“. Even the special name of a product has to be traditional or established by custom. To protect a foodstuff by the traditional speciality guaranteed indication, it is necessary to comply with the following:

- it has to be produced by using traditional raw materials,
- it has to have traditional composition and
- it has to be produced by the production and/or processing methods which reflect traditional forms of production or processing.

The producers of traditional products in Bosnia and Herzegovina should protect their products on the market by registering them first. There is a legal framework that allows them to protect their products, register them and put them on the market with distinguishing indications. Based on the Law on Food („Official Gazette of Bosnia and Herzegovina“, No. 50/04), the Council of Ministers has passed the Regulation on Designation of Origin and Protected Geographic Indications („Official Gazette of Bosnia and Herzegovina“, No.27/10) as well as the Regulation on Traditional Specialty Guaranteed Indication („Official Gazette of Bosnia and Herzegovina“, No. 27/10), which in full detail prescribe: the procedure for protecting the indication of origin, indication of geographic origin and indication of traditional speciality for the food items. The procedure of registering the indication (traditional speciality, designation of origin or geographical indication) takes approximately 12 months.

LOCAL BENEFITS FROM THE SUSTAINABLE MANAGEMENT OF AN ECOSYSTEM

To register a traditional product one has to submit the application. In Bosnia and Herzegovina this application is submitted to the Food Security Agency. The procedure of registering the indications is performed by the Registration Commission. The application for the Indication registration includes:

- *information about the applicant (first name, last name, title of the legal or physical entity, address, ID number, legal status);*
- *type of indication (traditional speciality, designated origin or geographical origin) that is being registered;*
- *statute of the association;*
- *title of the certification body selected by the applicant to check the quality compliance, as well as written consent by that body about the acceptance;*
- *compliance verification;*
- *producer's specification;*
- *power of attorney (should producer be represented by an assignee);*
- *applicant's signature;*
- *table of content of the application in accordance with the Annex to these guidelines.*

After having an indication registered in Bosnia and Herzegovina, it is possible to initiate the procedure for obtaining the EU level indication. The application is submitted to the European Commission directly, or via the Agency. Currently there is a total of 1,013 protected names of agricultural and food products in the EU, of which:

- *30 names with the traditional speciality guaranteed (TSG) indication;*
- *466 names with the protected geographical indication (PGI); and*
- *517 names with the indication of protected designation of origin (PDO).*

Majority of the protected products of the EU member countries comes from the Mediterranean ones: Italy (229), France (188), Spain (147) and Portugal (116). The examples of registered products at the level of European Union are categorized by countries and product categories.

Some of the examples of registered indications at the EU level:

- *Sheep's milk cheese from Greece „Feta“ – the Greek word „feta“ (φέτα) means „slice“. Feta is a traditional cheese made of sheep's (partly of goat's*

milk) originating from the Greek mainland or the island of Lesbos. It matures in a brine solution which gives it its characteristic and intensive flavor. The key elements of the traditional method for producing this unique product are native breeds of sheep and goat, extensive grazing and migrating flocks, specific regional climate and flora, traditional processing methods, specific aging conditions.

- Italian cheese made from the buffalo or cow's milk „Mozzarella di Bufala Campana“ – The Italian word „*mozzatura*“ means „to cut off by hand“. It is related to the traditional way of manufacturing, and since 1996, the „Mozzarella di Bufala Campana“ has the indication of protected designation of origin. This is a soft, white, skinless cheese with a distinctive filata-structure, 40-50% fat, shiny skin and characteristic flavor. It comes exclusively from the provinces of Caserta and Salerno, as well as several municipalities in the provinces of Naples and Benevento. After the processing of milk has been completed, the curd is left to set for a while and then it is treated by water heated up to around 80 °C. The cheese is then stretched and kneaded until it is smooth enough to be formed - it is cut into peaces and formed into balls weighing 100 to 125 grams.
- The Black Forest ham or „Schwarwälder Schinken“ in German – The product of protected designation of origin. Since 1997, the Black Forest ham has been protected by the protected geographical indication.
- The Styrian pumpkin seed oil – Traditional speciality from Styria labeled with the protected geographical indication.

Examples of registered indications at the level of Bosnia and Herzegovina:

- „Chestnut honey from the Cazin border“ – Since 2011, this commercial product has been protected by the label of protected geographical indication No. BAGO 09001. The chestnut honey is at the top of the scale when it comes to quality and medicinal properties. The area of Cazin border is situated within the Una-Sana Canton and is rich in huge chestnut forest complexes (approximately 5860 ha) and clean environment.

The autochthonous cheeses were researched by many experts (Dozet, N., 1991; Dozet, N., and associates 1974, 1981, 1983, 1983a, 1987, 1996; as well as Čaklović F., 1983; Filjak, D. and Dozet, N., 1953). The autochthonous cheeses are nowadays available within the offer of many rural areas that makes them distinctive and distinguished (Table).

Table 7. Autochthonous cheeses in Bosnia and Herzegovina

Cheese name	Identified area
Basa (Bjasa)	Bosanska krajina/Bosnian March, around Bihać and in wider area (Lika, Croatia)
White goat cheese	Herzegovina and several villages on the Vlašić mountain (Bosnia)
Kalenderovac cheese	Northern Bosnia: slopes of Mt. Motajica, areas near Mt. Majeвица and Šekovići
Livno cheese	Karstic fields: Livanjsko, Glamočko and Duvanjsko, Mt. Cincara and the surrounding mountains,
Fat cheese	Eastern Bosnia: around Čajniče, Tjentište, Sokolac and some other areas
Low-fat cheese	Wide area of Bosnia and Herzegovina
Presukača	Herzegovina and the Piva (Montenegro); Bosnia and Herzegovina: broad area of Gacko, Konjic and Sjemeč
Sirac	Bosanska krajina/Bosnian March, especially its mountainous areas
Dry or sheepskin full-fat cheese	Herzegovina
Fresh sour and dry sour cheese	Northern parts of Bosnia and Herzegovina
Travnik (Vlašić) cheese	Mt. Vlašić and surrounding mountains
Hard goat cheese	Herzegovina
Urda	Mountainous areas in Bosnia and Herzegovina
Zajednica	Eastern Bosnia: areas of kaymak (cream) production
Zarica	Eastern Bosnia

„**Basa**“or „**Bjasa**“– is produced from sheep’s or cow’s milk. The process takes place in a traditional small wooden vat with openings at the bottom. It is curdled with sour milk or buttermilk.

„**White goat cheese**“– in brine is produced by using the same technology as Travnik cheese. This cheese has a specific flavor and aroma. The slices are a bit smaller and softer than in the cheese produced of sheep’s milk.

„Kalenderovački cheese“– this type of cheese is characterized by the use of acetic acid to decrease the casein content. It is produced from partly skimmed or whole milk. Milk is heated to boil and sour milk and acetic or tartaric acid are added while hot. It is consumed fresh, after only 3-6 days of aging. Drying is applied for the purpose of extending the storage period.

„Livno cheese“– is produced from the sheep’s milk. Processing of milk into Livno cheese has started some 115 years ago, therefore it has become traditional. This is a hard cheese. Nowadays, it is also made of a mix of cow’s and sheep’s milk, as well as of pure cow’s milk. The production technology was brought to the livestock station in Livno, established during the Austrian-Hungarian rule, in 1888 by the Swiss cheese makers. The hard Swiss produced cheese „Gruyère“ served as a model and the product itself was initially called the „Swiss cheese“ (Filjak and Baković, 1974, Filjak and Dozet, 1953). The cross cut of the Livno cheese shows round, evenly distributed holes of medium size; yellowish color and nurtured skin. Its flavor is full, aroma pleasant and specific for hard sheep cheeses.

„Fat cheese“– production of this cheese is generally limited to the winter period as well as the periods that are not used in production of kaymak. It ages in brine and belongs with the group of quality products though it does not have any significant market value.

„Low-fat cheese - Posni sir“– Produced from skimmed milk after the cream has been taken out. On some farms it is then compressed into the sheepskin bags to ripen in them, while others ripen it in brine. There are many local names for this cheese: Torotan, Vareni cheese, Tarenik, Tučenik, Mješinski, Diga, Prljo, etc. It has a crumbly, lumpy texture, white-yellowish color and specific flavor. It has a relatively high content of proteins which is its main value.

„Presukača“– also known as „Gužvaš“ or „Učkuraš“. Presukača belongs with the group of steamed paste cheeses. It is characteristic for the plasticity of paste which allows easier molding. Some producers smoke it slightly. It can be consumed as fresh or stored for a longer period of time as its quality remains unchanged. It is rarely produced and belongs in the group of semi-hard and semi-soft cheeses.

„Sirac“– produced in the region of Bosanska Krajina, particularly in its mountainous areas. Until the 11th and 12th century, the Tzintzars (Aromanians) were the main cheese producers, whose cheese called „Sirec“ was well known for its outstanding quality (Pejić, 1956). It is produced of a mixture of fresh sheep’s and cow’s milk. It comes in a square shape, with tightly compacted texture and very few holes.

„Dry“ or sheepskin full-fat cheese – uses the same technology as boiled low-fat cheeses.

Fresh „Sour“ and dried „Sour“ cheese – is produced as a by-product in mak-

ing sour cream. The acids from sour milk or whey are used as coagulants. This cheese has fragile paste of white color and sour-milk flavor.

„Travnik cheese“– is produced from sheep’s milk. It is ripen in brine and its simple technology enables production in primitive mountain conditions. It is one of the most quality white cheeses in brine. It has a mild sour-milk flavor. It is still produced mostly in rural households.

„Hard goat cheese“– is consumed as relatively young, while for extended storage it is put in oil. At the cross section it is closed, white to white-yellow color and with small mass. When consumed fresh its taste is mild, while those kept in oil have somewhat tangier.

„Urda “ – is a cheese produced from whey. This cheese has many local common names, such as: Skuta, Furda, Hurda, Bjelava, etc.

„Zajednica“– is made of low-fat, fresh sour cheese and kaymak or freshly milked milk. Technology is fairly simple. „Zajednica“produced with kaymak has a layered structure, specific flavor and aroma.

„Zarica“– is produced from whey proteins by heating the whey and kaymak buttermilk to the boiling point. It has small mass, round or conical shape, and its paste is very hard, like in grating cheeses.

In addition to the above listed cheeses, in Bosnia and Herzegovina produced are some other autochthonous dairy products such as: kaymak, clarified butter, winter sour milk.



Picture 21. Regional distribution of autochthonous dairy products in Bosnia and Herzegovina (Dozet et al., 1974., 1996.)

HAND-MADE PRODUCTS

Rural areas of Bosnia and Herzegovina are hidden treasures of a number of hand-made products (foodstuffs, textile, metal, wood, etc.). The ideas of our rural population are an inexhaustible and unique asset that has to be recognized and adequately protected. The hand-made products of the rural areas serve various purposes: clothing, ornamental, housekeeping supplies, wickerwork, etc. The methods employed in the production of such items include: knitting, sewing, needlework, stitching, weaving, fretwork, etc. Many of the hand-made items are nowadays sold as souvenirs as they have lost their usage purpose in most households, e.g. manual

coffee grinder, water pitcher, rugs and prayer rugs, etc. On the other hand, preparation of native foodstuffs is still very much alive in many rural households (photos).



Dried fruit - pears



Home - made jam



Apples

Picture 22: Photos of the home-made foodstuffs

TOURISM

Sustainable utilization of various natural resources in rural environments enables a faster development of local economy through the expansion of tourist offer. This could be one of the best options for reducing the migration of the rural population to urban areas. In general, tourism represents a significant factor of change in a specific area which can influence economic and social relations, as well as political decisions. No other production activity is as closely related to environment, society and territorial resources as tourism.

The tourist resources may include:

- natural (parks, lakes, villages, caves, etc.),
- cultural (monuments, art towns, etc.),
- event-related (fairs, traditional festivals, manifestations, etc.), and
- specific rural tourism.



Picture 23. Touristic natural resource (Bastašica)

Due to changed lifestyle and consumption patterns, the ever growing interest of tourists is now shifted to rural tourism as it offers different typical landscapes and environments. The tourists are mainly in search for a healthier and more peaceful environment that offers more freedom of movement as well as local agri-foodstuffs. The trend of rural tourism is constantly rising. In Italian rural areas, for example, many initiatives related to the valorization of rural tourism have contributed to:

- raising awareness about the possibilities offered by sustainable development well fit into the territory,
- renewing the resources that were at risk from destruction or extinction (rural landscapes, rural buildings),

- valorizing the area,
- making an area more attractive than the others,
- connectivity: economic, social, cultural, historic and architectural characteristics of the area,
- developing organizational and production capacities of the area as a whole, and individual companies,
- success of activities related to rural tourism and
- increasing the interest of professional entrepreneurs in local tourism, etc.

In Italy, according to the Law 96/2006, the term rural tourism implies a form of tourism where farmers act as hosts to the tourists on their own farms (crops, forestry and livestock products). The rural tourism activities are performed exclusively within the farm's buildings. The employees may include: farmer him/herself and their family members or hired labor.

While entertaining, hosts have to pay close attention as to whether their guests have some special dietary requirements (vegetarians, vegans, gourmets, etc.). For example, vegans, unlike vegetarians use no products of animal origin (not even honey). Neither one likes to eat from the pots in which meat was cooked together with vegetables. They eat only the food of plant origin, soy milk, seitan, vegetarian pastes, fruit, and vegetables. Unlike them, the gourmets indulge themselves in rich, diverse as well as quality meals (specialities of the region).

In rural tourism it is allowed to:

- entertain the guests in buildings or in the open (camping),
- serve food and beverages that are grown/produced on the farm or the neighboring farms,
- organize various tasting events involving the farm products,
- organize equestrian tourism and
- organize recreational, cultural, sports and picnic related activities for the purpose of valorizing the area and its rural heritage.

The rural tourism was concentrated previously around small in hilly and rolling terrains, while today it involves rather large estates. Additionally, it gave an impulse to the development of other forms of rural tourism (holiday houses, bed and breakfast, small charming hotels, etc.). Cottages or the countryside residential buildings, for example, are the rural area buildings such as farm premises or granges converted

into facilities for the accommodation of guests, offering rooms, suites with kitchen, food service, sports and recreational activities.

This concept of rural tourism contributes to:

- the protection and preservation of traditional landscapes though the reconstruction and refurbishment of abandoned country buildings,
- the provision of jobs in agriculture and
- the valorization of typical local products.

The rural areas of Bosnia and Herzegovina are distinguished by the abundance of natural landscapes and richness of biodiversity. Such areas can promote natural heritage and serve as an example of positive effects of *slow tourism* through the following activities: trekking, birdwatching, equestrian tourism, picnics, overnight stays in country houses, hiking, cycling, long walks in nature, etc.

Birdwatching – The English words „birdwatching“ and „birding“ have become common terms used to identify people observing and identifying birds in their habitats. The bird-watching is actually a brand of the entire sector of slow tourism recommendable for rural areas. The bird-watching involves observation and studying of birds with the naked eye or through optical devices: binocular, telescope, and camera. The science that studies birds is called ornithology. A separate scope of ornithology is dedicated to the research and study of the behavior and routes of migratory birds by employing the technique of bird ringing (banding). More recently, ornithology has become more associated with protection of birds, i.e. protection of nature.

People involved in birdwatching is usually well educated and with a rather developed environmental awareness. The bird-watchers normally come to get familiar with natural heritage and observe birds that are not common to or do not live in the country they come from. Their purpose is to achieve this goal in a sustainable way and with as rational use of resources as possible.

In Bosnia and Herzegovina there are many amateur bird observers and one official ornithological society "Naše ptice /Our Birds". Areas that could be interesting in terms of potential development and expansion of the »birdwatching« activity are certainly the mountainous regions (Prenj, Čvrstica, Vran, Treskavica, etc.), karstic fields (Livanjsko, Popovo, Dabarsko, etc.), as well as protected areas (Hutovo blato, Bardača, NP »Una«, etc.). Database on birds in Bosnia and Herzegovina is very poor and does not reflect the factual state as Bosnia and Herzegovina occupies a rather high position on the list of countries rich in biodiversity.

LOCAL PRODUCTION OF RENEWABLE ENERGY AND PREVENTION OF CLIMATE CHANGE

The prevention of climate changes in rural areas is directly related to the production of renewable energy. It is a well-known fact that the utilization of renewable sources of energy is ecologically justifiable in the sense of mitigation of negative impacts (emission of greenhouse gases) and prevention of climate changes (warming). This is why the two important aspects should be considered together.

Unlike nonrenewable, the renewable types of energy cannot get exhausted in time though it is possible to completely exhaust their potentials. Some renewable types of energy are not possible to store or transport in their natural form (wind, solar energy), while some others are (water in watercourses and accumulations, biomass and biogas). The energy sources that are impossible to store have to be used momentarily or transformed into some other type of energy suitable for storing.

In 2001 the European Union adopted the Directive 2001/77/EC on renewable energy sources that is binding for the EU member countries' legislative, in terms of increasing the share of renewable sources in the overall production of electric power. The purpose of the Directive is to establish the total participation of renewable energy sources in energy consumption at 20 % and a minimum of 10% participation of bio-fuel in the EU transportation sector.

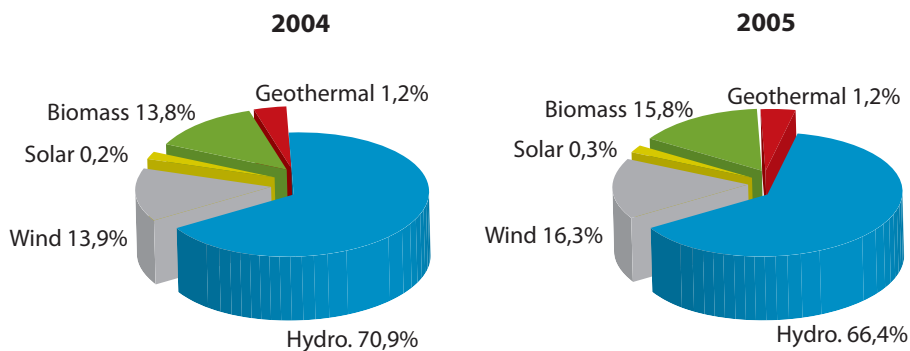


Chart 3. Share of some renewable sources of energy in the overall production of renewable electricity in EU countries (2006, 2007)

An interesting article about emission of greenhouse gases from the power plants of various types was published in the Austrian VEÖ-Journal 3/2004. It reviewed the conventional (large) hydro-power plants, small scale hydro-power plants

(32, 300 and 360 kW), wind power plants (600 kW and 1,5 MW), biomass power plant (700 kW and 11,5 MW), solar power plants (with solar cells on the house roofs and large solar power plants) and conventional thermal power plants -gas and coal powered ones (reported by Kalea, 2006).

Table 8: Total emission of climatically harmful gases from power plants (expressed in grams of CO₂-equivalent per produced kWh) – (CO₂-equivalent, g/kWh)

Type of power plant	Direct emission	Indirect emission	Total emission
Large-scale hydro-power plants	3,5-40	10-20	13,5-55
Small-scale hydro-power plants	3,5-35	15-20	18,5-55
Wind-power plants 600 kW	0	40	40
Wind-power plants 1,5 kW	0	50	50
Biomass-power plant 700 kW	13	50	63
Biomass-power plant 11,5 MW	18	45	63
Large photoelectric power plants	0	180	180
Small photoelectric power plants	0	220	220
Conventional gas powered thermal power plants	340	80	420
Conventional coal powered thermal power plants	820	100	920

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It is estimated that Bosnia and Herzegovina has the largest potential for producing energy from renewable sources (wind energy, solar energy, biomass energy, geothermal energy) in the Balkans, which is by 30% bigger than the EU average. In the rural parts of Bosnia and Herzegovina it is possible to establish a local production of renewable energy by utilizing their own potentials, and at the same time be no threat to the environment, in order to prevent climate changes: energy from biomass (bio-gas, alcohol fuel, biodiesel); wind energy; water energy (small run-of-river hydro power plants); solar energy; and, geothermal energy.

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BIOMASS ENERGY

The biomass energy is a bio-degradable part of the products, waste and agricultural detritus (plant and animal origin), forestry and other related industries. The agricultural biomass consists for example of straw, various plants' stalks (sunflower, maize, weed, and grass), cutting and pruning residues from orchards and vineyards, husks, shells, bark, fruit stones, rush, animal residues, etc. The wood biomass is characteristic for the energy plantations of fast-growing trees (poplar, willow).

The biomass energy comes as solid (wood, manure), gas (bio-gas, landfill gas) and liquid (bioethanol). The major advantages of using biomass as an energy source in rural areas include abundant potentials (planted crops) and waste materials from the primary types of production (agriculture, forestry). The gases resulting from the utilization of biomass may also be used to produce energy.

The advantage of biomass, in comparison with fossil fuels, is the smaller emission of harmful gases and waste matters. It is estimated that the load on atmosphere by CO₂ in case of biomass used as fuel is negligible since the amount of CO₂ emitted from combustion is equal to the amount of CO₂ absorbed during the plant growth, provided that felling and wood mass growth rate ratio is within the range of sustainability – 1 ha of forest area annually absorbs the same quantity of CO₂ that is released by burning 88,000 liters of heating oil or 134,000 m³ of natural gas (Šljivac D., and Šimić Z., 2009).

The exploitation of biomass also provides job opportunity (creation of new work positions and retention of the existing), increases local and regional economic activities, enables additional income in agriculture, forestry and wood industry from selling biomass – fuel. Biomass can also be used to produce electric power, heating energy or fuel for vehicles.

It is believed that dung of 120 cows can produce enough biogas to power a 50 kW engine, which is sufficient for covering the requirement for electric power of a smaller village. Anyway, the amount of energy and biogas obtained from animal refuse depends on the type of animal (Table) (Šljivac D., and Šimić Z., 2009).

Table 9. Quantity of biogas and energy produced from various types of animal waste

Type of animal	Type of refuse	Amount (kg/day)	Dry (kg/day)	Biogas (m3/day)	Energy (kWh/year)
Cow	Liquid	51	5,4	1,6	3400
	Dry	32	5,6	1,6	3400
Pig	Liquid	16,7	1,3	0,46	970
	Dry	9,9	2,9	0,46	970
Poultry	Dry	0,66	0,047	0,017	36

The alcohol fuel– ethanol can be produced from three basic types of biomass: sugar (sugar cane, molasses), starch (maize) and celluloses (wood pulp, agricultural detritus). Ethanol can be added to motor fuel, though it can completely substitute it as well. Currently the world leading nation in the production of ethanol as motor fuel is Brazil.

Table 10. Properties of alcohol fuels and gasoline

Properties	Ethanol	Methanol	Gasoline
Density (kg/m ³)	789	793	720-750
Heating value (MJ/kg)	21,3-29,7	15,6-22,3	32,0-46,5
Stoichiometric air/fuel ratio (kg/kg)	9,0	6,5	14,6
Boiling temperature at 1 bar (°C)	7,5	65,0	30,2
Viscosity level	-	0,58	0,60
Octane no.	106	112	91-100

Biodiesel is the commercial name for methyl-ester that can be found at the liquid fuels market. Methyl-ester is a chemical compound obtained by the process of etherification of vegetable oil (rapeseed, sunflower, soybean, palm, etc.) or animal fat with methanol in presence of a catalyst. Selection of the basic raw material for the production of biodiesel depends on specific conditions and circumstances in a specific rural area. In Europe, most used raw material for the production of biodiesel is the oil from rapeseed and sunflower (Chart), in America it is the soybean oil, and in Asian countries the palm oil.

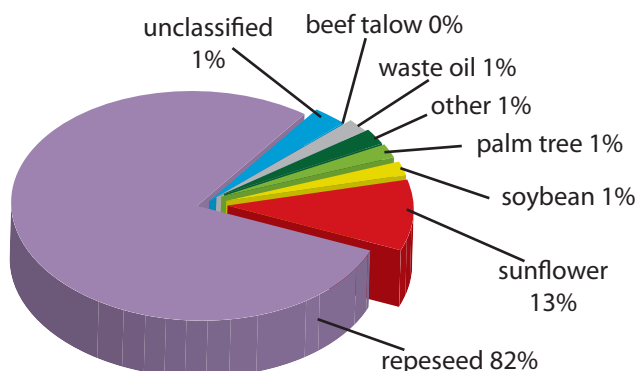


Chart 3. Raw materials used in production of biodiesel in Europe

One of the biodiesel's advantages has a significant relevance in the protection of environment: a total emission of CO₂ equivalent (g/km) biodiesel depends on the selected raw material and ranges from about 50 g/km (from sunflower) to about 110 g/km (from rapeseed), whereas in traditional diesel it is approximately 220 g/km.

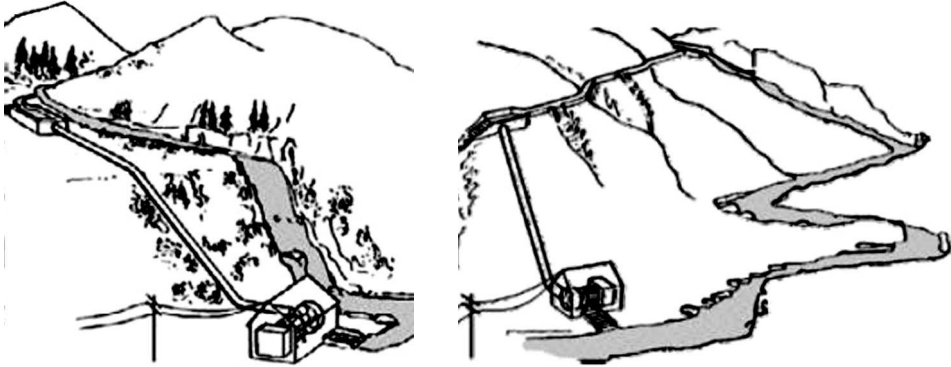
By introducing biomass crops into the structure of agricultural production, a part of traditionally agricultural land intended for food production is now redirected to "energy sector". This has already caused certain disturbances on the food market. Namely, change of production has led to a reduced level of supply of certain agricultural products, as well as to the growth of their prices. It is believed that this situation will get normalized after some time or that it will require legal solutions to govern the relations in this sensitive area. In any case, it is already possible to state that the introduction of biomass production in traditionally agricultural areas means an increased price of agricultural products as well.

Wind Energy

The wind energy is also a renewable source of energy which could be employed in rural areas and city outskirts, where the selection of location for installing the windmills is of particular significance. A windmill slows down the wind once it has taken out its energy and converted it into electric power. For this reason they should be installed far apart. Places suitable for installing the windmills are the elevations, hills with no obstacles in front of them. When it comes to this particular requirement, it seems that rural areas are most suitable.

Small-Scale Run-Of-River Hydro Power Plants

Provided that they extend near natural watercourses, the rural areas may be suitable for producing electric power in small run-of-the-river hydro power plants (Picture). Dams or barriers for the small-scale run-of-river power plants are built in a way which ensures minimum impact on the water's natural flow and life in it (benthos and pelagos).



Picture 24. Examples of run-of-river hydro power plants

7. PARTICIPATIVE MANAGEMENT OF NATURAL RESOURCES

It is just as hard to assess the consequences of changes in ecosystems as it is to manage them in an efficient way. There are two reasons for that. First, many consequences of the changes (be it degradation or measures within the sustainable management) occurring inside an ecosystem are too slow to become immediately visible and may be noted only from a certain distance relative to the time and place of their occurrence. Second, the expenses and benefits related to the changes within an ecosystem, apart from their spatial and time separation, are often grouped in different interested parties.

There is a considerable inertness, i.e. delay in the ecosystem's respond/reaction to a disturbance. For example, large amounts of phosphorus are accumulated in agricultural soils, threatening the rivers, lakes and ocean coastal zones with increased eutrophication. Furthermore, many years or even decades may pass before negative effects, e.g. erosion, fully develop and become visible. Likewise, it may take centuries for the global temperatures to reach the balance with changed concentrations of greenhouse gases in the atmosphere, and maybe even longer for the biological systems to respond to the climate changes. Moreover, some of the effects of ecosystem change may be detected only at a large distance from the place of their occurrence. For example, changes in the upper catchment affect the water outflow

rate and quality in the lower parts; similarly, the loss of a fish hatching area in the shoreline wetlands may cause the reduction of the catch fish in some remote location.

Many changes in the management of natural resources involved privatization of what used to be a common stock of resources (forest resources, natural land, peat, etc.). This way the individuals who depended on these resources (such as local population, communities relying on forestry, natural land, as well as other groups relatively marginalized within the sources of political and economic power) often lost their rights on these resources.

The inertness of ecological systems as well as the time and spatial separation of costs and benefits related to the changes in ecosystem, often result in situations where the individuals suffering the damages from ecosystem changes (local population, future generations, or land owners in the lower river zones) are not necessarily the same ones enjoying the benefits of such changes. The changes within an ecosystem usually bring benefits only to some people, while the others, who might have lost access to the resources (resources essential to their livelihood) or were threatened by the external effects related to the change, are only forced to cover the expenses. There are numerous reasons why the interested groups such as poor, women and native communities show a tendency of succumbing to the adverse effects of such changes.

In the context of economic valuation, the degradation of some of the ecosystem functions may sometimes be justified by the gain of more benefits in some other functions. This is the case with degradation of environment for the purpose of increased agricultural production. However, it often happens that the degradation of the ecosystem's functions exceeds what would be in the best interest of the society because it is very hard to evaluate many of the ecosystem functions that belong with the «public domain». Namely, although the people benefit from the ecosystem functions such as regulation of the quality of air and water or presence of the esthetically appealing landscape, there is no established market for such functions, and nobody is willing to pay for their maintenance. Literally, degradation of such functions of the ecosystems is „inestimable“.

If the estimate of economic losses related to the consumption of natural resources is translated into indicators of a country's total wealth, it considerably changes their balance, especially if the country is largely dependent on natural resources. Such countries, e.g. Ecuador, Ethiopia, Kazakhstan, Democratic Republic of Congo, Trinidad and Tobago, Uzbekistan and Venezuela, registered a growth of the net national wealth in 2001, even if actually they suffered the loss in net saving if the consumption of natural resources (energy, forests) and estimated damages induced by emission of carbon into the atmosphere (related to the contribution to climate changes) are included in the calculation.

INSTITUTIONAL FRAMEWORK OF SUSTAINABLE MANAGEMENT

It happens very often that the measures undertaken to slow down the degradation of ecosystems do not belong with the domain of direct managers. For example, the forest management is mostly influenced by indirect decisions and measures made outside the forestry sector, such as the policies related to various elements of trade sector, macroeconomic policy, as well as the policies of other sectors such as agriculture, infrastructure, energy and mining. An efficient set of measures (responses) which would provide sustainable management of ecosystems should include the above mentioned indirect factors.

First and foremost, the management efficiency is best reflected through the surmounting of common obstacles:

- Inadequate institutional and administrative organization, including the presence of corruption and poor system of control and sanctioning,
- Non-functioning market for all the functions of ecosystem and improper establishment of economic incentives,
- Social factors and adopted patterns of behavior, including lack of political and economic power in certain groups (such as those in need, women, indigenous population) that are pronouncedly dependent on the functions of ecosystem and are affected by their degradation,
- Insufficient investments in development and expansion of technologies which could increase the efficiency of utilization of ecosystem functions and reduce harmful effects of various factors on the changes of ecosystem and
- Lack of knowledge (as well as poor use of the existing knowledge) about the functions of ecosystem, management, policies and technological and institutional measures that could increase the benefits from these functions while preserving the resources.

All these obstacles are additionally augmented by a lack of people's and institutions' ability to assess and manage the functions of ecosystem, lack of public awareness and lack of awareness among the decision makers about the risks associated with degradation of ecosystem, as well as with the possibilities that would ensure that the ecosystems are managed in a more sustainable way.

Institutional Changes

The existing national and international institutions are not designed to be able to successfully deal with the decisions on ownership and access to resources; the right on participation in decision making and regulation on individual types of use of resources or disposal of waste. All these decisions may have a significant impact on defining the sustainability of ecosystem management and provide basic determinations who is gaining and who is losing because of the changes within an ecosystem. Corruption, being the major obstacle to efficient management of ecosystems, is also a product of poor control and sanctioning systems.

The institutional changes are sometimes necessary for creating conditions that would enable more efficient management of the ecosystems, while, in some cases, the existing institutions may fulfill these requirements, but having to face huge obstacles. These requirements mainly reflect in better cooperation of the sectors, as well as coordination of measures from several levels. However, since a large number of issues related to sustainable management of the ecosystems have come into the focus of attention only recently, and given that they were not taken into consideration at the time of the establishment of current institutions, the institutional changes may prove necessary especially at the national level.

Economic and Financial Interventions

Economic and financial interventions are powerful managing tools in the utilization of ecosystem functions. As many of the ecosystem functions are not offered at the market, the market cannot provide proper valuation which would otherwise contribute to the sustainable utilization.

The market mechanisms and most economic instruments may be efficient only if the support institutions exist too. Therefore, it is necessary to build institutional capacity that could subsequently enable a broader application of such mechanisms. The optimal economic and financial interventions in the sense of sustainable management of natural resources include:

- Elimination of subsidies that promote excessive exploitation of the ecosystem functions, and where possible, transfer of these subsidies to the promotion of functions that are not offered at the market.
- Increased application of market oriented economic instruments in the management of the ecosystem functions. These include:
 - *Taxes or user fees for the activities with "external" costs* (exchanges that are not included by the market). The examples include taxes

on excessive application of fertilizers and user fees for eco-tourism. Another example is the non-selective agricultural subsidies that ultimately result in a surplus of products and pollution of water and soil by fertilizers and pesticides.

- *Establishment of market, through the establishment of a trade system.* One of the markets related to the functions of ecosystem with the highest rate of growth is the carbon market. The value of the carbon trade (buying and selling rights on the emission of CO₂ into the atmosphere) in 2003 amounted to approximately 300 million USD. About one quarter of this trade is related to the investments into the ecosystem functions (water energy or biomass). It is speculated that by 2010, this market reached the value of some 44 billion USD. The establishment of a market in the form of fertilizer trade system may be a cheap way for reducing the excessive accumulation of nutrients in the United States of America.
- *Paying for the ecosystem functions.* For example, in 1996, Costa Rica introduced a national system of payment for *conservation services* in order to encourage the land owners to ensure normal functioning of the ecosystems. Within this program, trade inter-mediators conclude contracts between the “buyers” and local “sellers” of the ecosystem functions: sequestered carbon, biodiversity, water catchment functions and natural attractions. Another innovative mechanism for financing conservation services is the “biodiversity compensation”, where developers pay for all the conservation measures as a compensation for the eventual damages their project could cause to biodiversity.
- *Mechanisms that could allow consumers to state their priorities through the market.* For example, the current schemes for the certification of sustainable practice in fishery and forestry provide people an opportunity to improve sustainability through their choices in the capacity as consumers.

Social Factor and Behavior Patterns

Social factor and behavior patterns including population policy, public education, actions of civil society, and granting rights to the communities, women and youth may be of great assistance in addressing the problem of ecosystem degradation. These are generally the interventions initiated and implemented by the interested parties while exercising their procedural or democratic rights in the effort to improve the ecosystems and human wellbeing.

The optimal interventions in the area of social awareness and routine habits in the sense of promotion of sustainable management of natural resources include:

- *Measures for reducing the consumption of those services which endanger normal functioning of an ecosystem and which are not managed in sustainable way* – pertain to the organized influence on the selection of what an individual shall consume. It starts from the assumption that their choice is not influenced only by price, but also the behavior factors related to the culture, ethic and values system of an individual or a society. The behavior changes in people able to reduce demand for the services which threaten the ecosystem functions can be encouraged by government measures (such as programs of educating and raising public awareness, or improvement of management in the party which represents requirements), industry (mandatory use of raw materials coming from sources that are certified as sustainable, or improved labeling of products), and civil society (through raising public awareness). The efforts to reduce overall consumption sometimes need to incorporate measures that would increase the access of the specific groups of people, e.g. those in need, to the very same functions of the ecosystem and their consumption.
- *Communication and education.* Improved communication and education are essential to achieve objectives of the conventions on environmental protection, the Johannesburg Plan of Implementation, as well as to sustainable management of natural resources in general. Both the public and the decision makers may benefit from the education in sustainable management of ecosystem and human wellbeing. Unlike communication and education whose significance has been understood, ensuring of human and financial resources that would do an effective job has become a constant problem.
- *Granting rights to the groups that are extremely dependent on the ecosystem functions* - or are directly affected by its degradation, to include women, local population and youth. Women's participation in decision making processes is often limited by economic, social and cultural system despite their knowledge about environment protection and their potential. Young people are also an interested party in the sense that they will live to see the long-term consequences of the current decisions pertaining to the function of ecosystem. Control of traditional homeland by the local population is often presented as a benefit the local population and their supporters have from the environment, though the primary justification is still based on human and cultural rights.

Technological Measures

With respect to an increasingly growing demand for services provided by the ecosystems, as well as all other ever growing pressures on the ecosystems, the development and expansion of technologies designed to increase the resources efficiency or reduce the negative impact on climate change or accumulation of nutrients, have become essential. Technological changes are necessary for the fulfillment of a growing demand for certain ecosystem functions, where technology offers a hope that this demand could be met in the future. There are already available technologies (at reasonable price) for the reduction of nutrient pollution including technologies for the reduction of the known sources of pollutant emission, change of conventional agro-technical practice, as well as precise techniques for soil cultivation that can help control the application of mineral fertilizers or pesticides on a specific field. However, in order for these new technologies to be used to the extent sufficient to slow down, and ultimately reduce the increased accumulation of nutrients, it is necessary to adopt some new systemic measures (policies). Anyway, negative effects on the ecosystems and human wellbeing are sometimes the result of new technologies; therefore, it is necessary to check them carefully prior to their introduction.

The optimal technological measures in terms of promoting the sustainable management of natural resources comprise:

- *Promotion of technologies enabling increased yields with no harmful effects related to water outtake, accumulation of nutrients and pesticides.* The agricultural expansion will, even in the twenty first century, continue to be one of the major causes of biodiversity losses and environmental degradation in general. Development, assessment and spreading of technologies that may increase production of food per area unit in a sustainable way and with no detrimental concessions with regard to excessive consumption of water or application of mineral fertilizers and pesticides, will significantly reduce the pressure on other functions of the ecosystem.
- *Restoration (renewal) of the ecosystem functions. The restoration measures are common in many countries today.* The functions of ecosystem that existed prior to degradation can be restored to a considerable degree by bringing the conditions in ecosystem possibly into their original state. However, the cost of restoration is generally extremely high in comparison to the cost of prevention of the ecosystem degradation. Not all the functions can be restored, and some severely degraded functions sometimes take a long period of time to recover.

- *Promotion of technologies for energy efficiency and reduction of the greenhouse gases emission.* A considerable reduction of the emission of greenhouse gases is technically possible thanks to a large number of new technologies in the energy and waste management sectors. The reduction of the projected emission of greenhouse gases will require technologies that imply transition from one type of fuel to the other (from coal/oil to gas); increase the efficiency of energy plants; considerably higher employment of technologies that use renewable sources of energy, followed by a better energy efficiency in the sectors of transportation, construction and industry. It will also include development and implementation of a support policy in order to overcome the obstacles to spreading such technologies through the markets; more funding for researches and development provided by public and private sectors; and, efficient transfer of knowledge and technology.

Measures in the Area of Knowledge

An efficient management of ecosystems is limited both by the lack of knowledge and information about various aspects of the ecosystems, and the failure to properly use the existing information as a support to the management related decisions at all levels. In most regions, for example, there are relatively little information about the status and economic value of the services provided by normal functioning of the ecosystem while their consumption is almost never presented in the national financial reports. Basic global information about the extent and trend of the utilization of various types of ecosystems and soil is surprisingly scarce. The models used for projecting the environmental and economic status have a limited capacity for the incorporation of ecologic "feedback", including the non-linear changes in ecosystems.

Concurrently, the decision makers do not use all relevant information that is available to them. This happens partly due to institutional constraints that prevent the current scientific information with political relevance to become available to the decision makers, and partly because of the inability to incorporate other types of knowledge and information (such as traditional and professional expertise in this area) which are often very valuable to the management of ecosystems.

The optimal measures in the area of knowledge aimed at the promotion of sustainable management of natural resources include:

- *Integration of non-market values of ecosystem such as air and water quality regulation, esthetic value, spiritual and traditional values, into the system of managing resources and investment decisions.* Most decisions on the way of managing the resources and investments begin with the consideration of financial costs and benefits the chosen alternatives may have. The decision making may be quality only if there is complete information about economic value of alternative options, as well as if the advisory mechanisms are included in order to include the non-market values of ecosystem into considerations.
- *Employment of all relevant forms of knowledge and information during the process of assessing and making decisions, including traditional and local expertise.* Efficient management of ecosystems usually requires the «local» knowledge, i.e. information about the specific characteristics and history of a given ecosystem. Traditional knowledge or professional expertise of the managers of local resources may often be an important asset, however, it is rarely involved in the process of decision making, and very often it is even pointlessly rejected.
- *Improvement and maintenance of personnel and institutional capacity to assess the effects of ecosystem changes on human wellbeing and to act based upon such assessments.* The agriculture, forestry and fishery require bigger technical capacities. However, the capacities that exist in these sectors, though limited in many countries are still much bigger than the capacity for efficient management of other ecosystem functions.

Various frameworks and methods may be employed in order to make better decisions in despite of unreliable data, projections, context and scales. The *active adaptive management* may be an exceptionally valuable tool for reducing the unreliability concerning the decision making in ecosystem management. The commonly used methods of decision making include the analysis of costs and benefits, risk assessment, multifactorial analysis, precautionary principles and vulnerability analysis. Development of various scenarios is also a good tool for dealing with many aspects of unreliability, however, our limited understanding of the processes of human and ecologic interactions coats any individual scenario with its own typical unreliability.

The active adaptive management is a tool that can be exceptionally valuable given the high level of unreliability that is associated with the connected socio-economic systems. It includes the designing of a management program that will test (check) the hypothesis about how the components of a system function and mutually act, thus reducing the unreliability much faster than it would normally happen.

LOCAL GOVERNMENT AND MANAGEMENT OF NATURAL RESOURCES

Many thematic units and their solution in the sustainable utilization of natural resources and sustainable management of environment pertain to the solution of problems at the level of local communities – municipalities. That is why the role of municipalities is so important for the accomplishment of goals set forth in the Agenda 21. The bodies of local communities (rural areas) play the crucial role in educating and mobilizing the public, as well as in responding to the public request to promote sustainable development.

The local communities manage their economic, social and ecologic infrastructures, monitor spatial plans, make decisions on local environment protection policy and participate in the implementation of the national environmental policies. For this reason, each local community, through the communication with its citizens, local institutions, cantonal and state-level agencies, should adopt its own specific strategy for sustainable development in the form of the Local Agenda 21, and continuously supervise the implementation of the strategy, its application and constant improvement. These should be characterized by the methods of work based on dialogue, consultation and reaching of consensus on all relevant issues, while the ultimate goal should be the development of a long-term action plan at local level aimed at the achievement of sustainable development

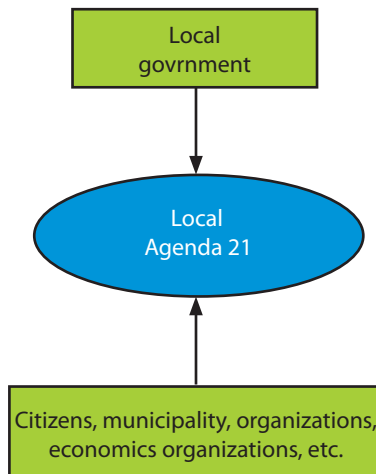


Chart 4. Local Agenda 21

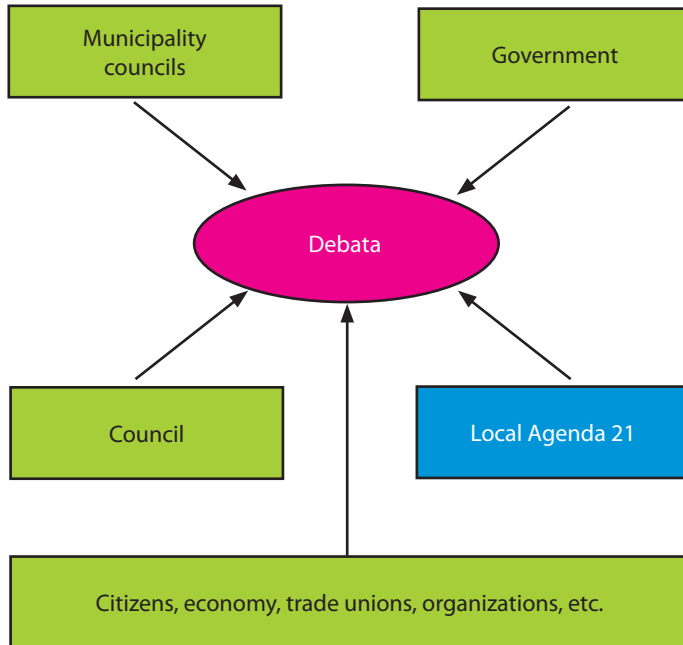


Chart 5. The process of the Local Agenda 21

The European Community has launched an initiative for mobilizing and implementing rural development in rural communities through the local public-private partnerships (*Local action groups*). This initiative was successfully presented by the LEADER project - *Links between Actions for the Development of the Rural Economy*. The objective of this approach is to help people, associations, companies and other potential factors in a rural area to look into the potential of their area and encourage the implementation of integrated, quality and original strategies for sustainable development. One of the basic characteristics of this initiative is placing the emphasis on local population that was always considered the key factor of rural areas. What made this process specific, at the very beginning, was confidence in local people and their knowledge and skills to find out what would best suit their environment, culture, tradition and skills.

The main characteristics of this approach are as follows:

- local partnerships and local action groups (LAGs),
- local development strategies,

- public-private partnership,
- the „bottom-up“ approach,
- inter-sectoral development,
- innovative approach,
- cooperation,
- participation and work within the net (network) and
- local partnerships.

The approach based on the so-called „target area“ which encompasses a smaller territory linked by common traditions, local identity, sense of affiliation or common needs and expectations, which serves for the implementation of rural areas. The existence of such areas facilitates implementation of the principles of sustainable development because of easier identification of the local strengths and weaknesses, threats and opportunities, internal potentials, as well as major bottlenecks. A selected area must have sufficient linkages and critical mass in terms of human, financial and economic resources.

The bottom-up approach means that the local factors take part in making decisions concerning the strategy and selection of priorities that should be implemented in their local areas. The measures aimed at supporting the *bottom-up* approach should be designed and implemented in a way which suits the requirements of the community best. This approach functions in fifteen EU countries that have LAGs.

Local action group (LAG) is a legal entity established for the purpose of providing support to the development of rural regions. It consolidates representatives of small and medium scale enterprises, local self-government, non-profit organizations and other local actors from various lines of activity, who jointly decide on a single approach aimed at development of their region. It is LAG's responsibility to identify and implement a local development strategy, make decisions related to the funding sources and manage the funds. The local action groups have often proved to be more useful than some other approaches to incent sustainable development, as they:

- aggregate and combine human and financial resources from different sectors (public, private, civilian, etc.),
- pool local actors in joint projects and inter-sectoral activities for the purpose of achieving synergy, joint ownership, and critical mass required for the improvement of the economic competitiveness of the region,

- strengthen dialogue and cooperation between various rural actors and
- facilitate the process of adaptation and change in agricultural sector through the interaction of different partners.

The establishing of LAGs follows several principles. A newly established LAG represents a rural area having more than 5,000 and less than 150,000 inhabitants, as well as towns with the population less than 25,000. The LAG's territory represents an independent whole and cannot be included into the territory of other LAGs. Same location of one independent LAG must not have more than one LAG when it comes to partnership, strategy and territory.

Each development plan of a LAG must be structured in accordance with one of the following topics:

- use of know-how and new technologies to create competitive products and services of the rural area,
- improvement of the quality of life in rural areas,
- creation of added value for local products and
- achievement of optimal utilization of natural and cultural resources.

The most active actors in local initiatives are as follows:

- professional organizations and associations (farmers, micro enterprises, etc.),
- commercial associations, citizens,
- citizens and their local organizations,
- environment protection societies,
- media and
- women's associations, youth associations.

The innovative approach may imply introduction of a new product, new process, new organization or new market. This simple definition of innovativeness applies to both rural and urban areas. The innovativeness in rural areas may imply transfer and adjustment of innovation developed in some other area, modernization of traditional forms of know-how, or seeking new solutions to the existing rural problems other intervention measures failed to resolve in a sustainable and satisfying way. The adoption of information and communication technologies in rural

areas may become an important channel that would provide access to innovations for the rural population.

Integrated and inter-sectoral approach implies that the local development strategy must have an inter-sectoral background, i.e. it must integrate the activities of several sectors. Integration may pertain to the activities conducted in one sector, to all program activities or specific groups of activities, or it may pertain to the connections between different economic, social, cultural and natural sectors.

Networking involves exchange of accomplishments, experiences and know-how among the action groups, rural areas, authorities and organizations involved in rural development, no matter whether they are direct participants in their creation or not. It also pertains to the transfer of good practice, dissemination of innovativeness and development based on the knowledge acquired in local rural development. There are various forms of networking: institutional, national, regional and local.

Cooperation allows different LAGs with identical or similar projects to work out jointly certain issues or add value to the local resources. This could be, for example, a common marketing campaign or some tourism initiative based on common cultural heritage.

8. INTRODUCTION TO THE ENVIRONMENTAL IMPACT ASSESSMENT

The assessment of impacts on the environment is discussed while making decision on the implementation of a defined project (investment intervention). In the sectors of agriculture, forestry, energy, industry, transportation, waste management, tourism, fishery, spatial planning and telecommunications, decisions used to be made in accordance with the criteria such as profit, jobs, standard of services, etc., while the impact on environment was totally neglected. However, the environment has become a significant factor of production, its price is on a constant rise as well as its „relative weight“.

The modern day process of decision making involves the environmental criteria along with other indicators. In case that some investment interventions make an impact on environment, they are not necessarily dismissed (everything impact the environment), but the acceptability of these impacts in the context of current alternatives is assessed. Under the circumstances where in addition to the long-term exists the so-called short-term sustainability, the decision makers need to make an integral assessment of various aspects (economic, social, environmental, geopolitical, etc.). The methods they use include the multi-criteria and cost-benefit analyses.

The Environmental Impact Assessment (EIA) is a procedure which provides that all environmental implications of a given decision (effects in all their manifestations) have been taken into consideration prior to its adoption (prior to the issuance of approvals, prior to the issuance of licenses, prior to the adoption, etc.).

The EIA procedure includes:

- Analysis of the possible/probable impacts of a specific decision (intervention) on the environment, which includes:
 - identification of possible negative impacts on the environment,
 - their prediction,
 - description,
 - evaluation,
 - proposed alternative measures,
 - proposed measures for mitigation or avoidance of the environmentally negative implications,
 - program of control, monitoring and managing during the intervention and in the aftermath.
- Documenting the analysis (evaluation) of the report (each individual decision preceding the final decision should be documented).
- Consultations with the public (ideally, consultations should be convened with the interested and professional groups throughout the process of Assessment development).
- Taking into account all the reports and comments from the Analysis while making the final decision on the continuation or withdrawal of the subject matter.
- Informing the public about the decisions taken.

The Strategic Environmental Assessment (SEA) is an assessment at the initial stage of planning some investment intervention, where several options are still open. It is based on the consideration of a bigger picture where the overall impact of individual interventions is easier to be understood. The Strategic Impact Assessment is used to evaluate the impact of plans, programs or policies on the environment. In comparison with the Environmental Impact Assessment (EIA), the Strategic Environmental impact Assessment is more proactive, more flexible and focused on the objective and framework implications rather than specific impacts as they are impossible to identify at the initial stage. The SEA hierarchically sets a framework wherein the EIA is more effective and efficient as well. For example, the Environmental Impact Assessment is applied specifically to some facility (wind-power plants, highways, waste disposal sites, etc.), whereas the Strategic Environmental Impact Assessment is used for planning the development of such facilities in the region, which requires determination of the total maximum capacities and provision of

general guidelines or acceptability criteria for every individual intervention of the subject implementation.

EU LEGISLATION FOR EIA AND SEA

The Environmental Impact Assessment Directive (EIA9) was adopted in 1985 (85/337/EEC), and amended in 1997 (97/11/EC). Subsequently, in 2003, another Directive was adopted (2003/35/EC) to support and „verify“ the so-called Aarhus Convention. The latter directive requires the participation of the public in the entire process where it has the right to challenge a decision before the court. The Environmental Impact Assessment Directive stipulates:

- Category of an intervention/project which has to undergo the following procedure:
 - mandatory Environmental Impact Assessment - Annex I
 - screening and scoping (analytical review) - Annex II
- Procedure – where the participation of the public is the main topic of discussion. Before making decisions it is necessary to inform the public and make consultations about the facts the subject decision relies upon. Additionally, the public needs to stay involved after the decisions have been made. A decision is made by the competent authority while taking into account the comments, suggestions or reports provided by the public.
- Report:
 - Description of the project scope and design,
 - Description of the intervention location,
 - Description of measures aimed at avoiding, reducing or mitigating adverse impacts on the environment,
 - Identification and evaluation of the most significant effects of the intervention on the environment,
 - Alternative solutions provided by the investor and considered along with the justification of the selected option with regard to its impact on the environment and
 - Non-technical summary of the above listed.

The Strategic Environmental Assessment Directive (SEA) was adopted in 2001 (2001/42/EC). It explicitly suggests active participation of the public throughout the procedure, instead of a mere response to the report. It also explicitly emphasizes monitoring aimed at early detection of the anticipated implications/effects on the environment. The SEA directive also foresees an analytical review - screening and scoping.

The Strategic Environmental Assessment is something that every plan from the sectors of agriculture, forestry, energy, industry, transportation, waste management, water management, tourism, fishery, spatial planning and telecommunication has to undergo. The SEA procedure is mandatory for everyone participating in the definition of the framework for the approval of projects from the Annex I and Annex II of the EIA Directive and are required an assessment according to the Habitats Directive (92/43/EEC).

ROLE OF VARIOUS ACTORS IN THE OVERALL ASSESSMENT CYCLE

The participation of various actors is believed to be the core of the EU Directives on the environmental impact assessments. The reason may be viewed in the context of several fundamental human rights that are included in the Charter of Fundamental Rights of the European Union:

- the right to life
- the right to a healthy, protected and preserved environment and
- the right to making decisions pertaining to the environment.

Listed below are the common actors in the process of environmental impact assessment - EIA:

- public,
- administration,
- entrepreneurs,
- investors, and
- other stakeholders.

In addition to being mandatory, the participation in the assessments may also be useful to many. For example, the entrepreneurs participating in the environmental impact assessment have the opportunity to improve the project based on the additional useful information, to establish a consortium or to ensure that their operation is supported rather than obstructed by the public („read a map but ask the villager, direct approach“). Thanks to a better transparency of the decision making process, the administration becomes more accountable, but equally more trusted. Additionally, it is more likely that the project will be recognized as socially beneficial, etc.

In practice it often happens that the public has some higher priorities as some have no either time nor interest to take part in the process of Assessment; the entrepreneurs are always rushing when it comes to the implementation, while to the administration, this is just the additional workload. Sometimes the opportunity to participate in the process of decision making goes unused; there is a lack of support, as well as some direct partial interests that oppose the implementation.

The most common public comments on the existing practice related to the public debates and discussions about environmental issues, may be summarized as follows:

- Information of the public has to be more direct and more active. The current level of public information is not satisfactory since notifications published in the newspapers are simply „invisible“. Their primary purpose is just to „formally“ meet the legal requirement rather than include the public into the process.
- Information must be made available (without too many formal procedures involving requests, applications, questionnaires, etc.) on the internet web pages, with free download.
- Length of the period designated for the public inspection is usually short, and particularly in combination with insufficient information, people learn about this possibility late.
- The comments and suggestions provided by the public are just formally responded to, and/or simply ignored, so that the public opinion has a way to small „weight“ of the influence in the process of decision making.
- The public needs to be involved in a more complete, active and partnership way since the public inspection and debate represent tools that are insufficient when it comes to their inclusion.
- Projection of impacts on the environment is in a higher scientific sphere.

- The public has considerable doubts with regard to the experts' impartiality.
- The symptoms like NIMBY (Not in My Back Yard), BANANA (Build Absolutely Nothing Anytime Near Anyone) or NIMET (Not In My Elected Term) are not often understandable or clear.
- A part of impacts is not always possible to predict with precision and certainty.

The majority rule in democratic societies is limited by the individual's human rights to a healthy and preserved environment. Although the reason for the public's participation in this process is to „*amend the scientific information*“, it happens very seldom that everyone is happy with the passed decision. The system of values and interests vary within the community itself while the profit and cost made by an intervention are not evenly distributed. Sometimes, the damages or benefits from an intervention continue to disrupt the interests of one part of the community. For example, the establishment of some economic facilities (e.g. fish farms) brings the job opportunity to some, while the others, e.g. owners of the holiday homes, who used that space for rest and recreation, become an unhappy minority.

The efficiency of the Environment Impact Assessment also depends on the general state of the society that has gradually been established by other activities aimed at promotion of environment protection (education, cooperation and trust, transparency, etc.).

STATE OF THE ENVIRONMENT INDICATORS

As it is stated above, the entire concept of sustainable development is based on the principle that daily activities be executed in an environmentally acceptable way. Generally, this is cheaper and more practical than any subsequent interventions. In such a way, this is the context in which the environmental impact assessment should be considered, i.e. checked if the agricultural activities have negative impacts on the agro-ecosystem and the surrounding ecosystems.

The European Environment Agency (EEA) is the leading European public institution established for the purpose of providing environmental information and data; support to the sustainable development; and, provision of a measurable improvement of the European environment. The sector related topics addressed

by EEA include agriculture, chemicals, energy, transportation, development and planning of land use, and international topics. The EEA coordinates the work of the European Information Network (EIONET). EIONET consists of a network of experts and five thematic centers (European Topic Centers – ETC), which cover the following areas: air and climate, biodiversity, land use and spatial information, resources and waste, and water.

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In 2004 the European Environment Agency (EEA) developed a set of indicators for the status of environment („EEA core set“) that is organized in accordance with the „DPSIR“ concept. These indicators refer to several environmental topics: land (terrestrial) environment, biodiversity, water, waste, climate changes, air pollution and status of the ozone layer, as well as four sector-related topics (agriculture, energy, transportation, and fishery). The EU member countries prepare reports for EEA on a regular basis.

In the EU countries the DPSIR concept represents a standard methodology which uses the indicator approach to depict:

1. **Driving Forces** – causes of impact on environment (consumption of agro-chemicals, water, energy, production methods, and number of farmers).
2. **Pressures** – pressures on environment caused by drivers (emissions of pollutants, erosion, change of land use, etc.).
3. **State** – state of environment (soil quality, nitrates and pesticides in water, land use, depletion of species, etc.).
4. **Impact** – the effects of pressures (GHG emissions, nitrates pollution, use of water, etc.).
5. **Response** – measures and tools for preservation of the environment (agricultural policy, market economy, training, etc.).

The new concept of agricultural development promoted in Maastricht (*Multi-functional Character of Agriculture and Land*) insists on agricultural interventions that are environment friendly. A significant role in this concept is played by the sustainable land management indicators, the so-called agro-ecological indicators, based on which the level of sustainability of an intervention made in agricultural practice is determined. Assessing that land has been neglected for too long, the European Commission (EC) has launched a series of activities aimed at effective protection of soil in Europe. Part of these activities is the establishment of the European Soil Bureau Network - ESNB.

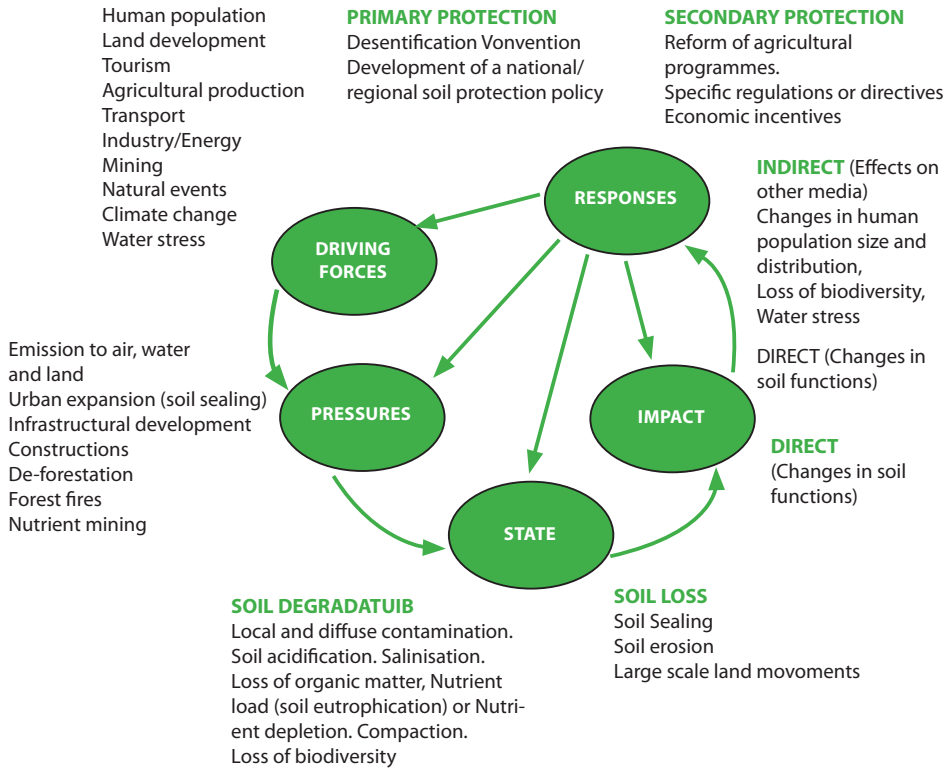


Chart 6: The DPSIR concept

The indicators are representative values of a subject area which quantify the information by aggregating various measurements into a single numerically representative value. The indicators help us to better understand the complex ecological issues as they provide quantitative information in a simple and clear way. They need to be: representative, relevant, convincing, transparent and accurate. There are multiple criteria for selecting the indicators, but the main ones include: is the issue from the aspect of its negative effect on the environment; is their collection, measurement and presentation possible or not, etc.

The Environment Agency in the neighboring Republic of Croatia also uses the DPSIR methodology and has its own National list of indicators of the state of environment with a total of 266 different indicators (Agency for the Protection of Environment, 2010). The indicators are presented in a table where each one of them has its ordinal number, group, indication, full name and place it occupies within the DPSIR system.

For the purpose of information and classification of data, and based upon an initiative by the European Commission, the European Environment Agency implemented the project dubbed „IRENA operation“(Indicator Reporting on the Integration of Environmental Concerns into Agriculture Policy). The process of development of this unique list of agricultural-environmental indicators used the sets of tools developed by OECD, EUROSTAT, EEA, and EU Research Programmes-ELISA, through analyzing the gaps and requirements. The project lasted from 2002 through 2005. Within the IRENA operation, a list of 35 indicators divided into indicator groups based on DPSIR model, approved by the EEA, was developed.

Table 11: The IRENA set of agricultural/environmental indicators

Group	Sub-group	No.	Name of Indicator	Explanation
Responses of society	Policy	1	Areas covered by agricultural/ environmental incentives	Agrarian and environmental policies. Changes in technology, skills and attitude of buyers and producers
		2	Level of implementation of good agricultural practices	
		3	Level of the achievement of environmental objectives	
		4	Participation of agricultural areas in the total protected nature areas	
	Trade indications	5.1	prices of organic products and their participation at the market	
		5.2	Income of the organic agricultural farms	
	Techniques and skills	6	Level of farmers' training	
	Positions	7	Area under organic agriculture	
Driving forces	Utilization of investment	8	Fuel consumption	Method of agricultural production, consumption and utilization of agro-chemicals, energy, water, etc.
		9	Consumption of plant protection chemicals	
		10	Consumption of irrigation water	
		11	Consumption of energy	
	Use of land	12	Conversion of land use	
		13	Trends of change of agricultural production systems	
		14	Farm management procedures	
	Trends	15	Intensification/extensification	
		16	Specialization/diversification	
17		Marginalization		

Group	Sub-group	No.	Name of Indicator	Explanation
Pressures	Pollution	18	Nutrient balance Emission of ammonia from agriculture	Accumulation of nutrients in soil and water, emission of ammonia and methane
		19	Emission of methane and nitrate oxides from agriculture	
		20	Soil contamination by pesticides	
		21	Water pollution	
	Exhaustion	22	Utilization of water	Improper utilization of water, soil, destruction of natural and abandoned habitats, loss of natural diversity
		23	Erosion of agricultural land	
		24	Change of agricultural land cover	
		25	Genetic diversity	
	Protection and improvement of environment	26	High-value agricultural areas	Formation/ protection of landscape, habitats, land cover; destruction of natural and abandoned habitats; loss of natural diversity
		27	Production of renewable energy	
State	Natural diversity	28	Depletion of bird species	Trends in bird populations on the farms
	Natural source	29	Soil quality	Quality of soil, quantity and quality of water
		30	Nitrates and pesticides in water	
		31	Levels of surface water	
	Landscape	32	State of the landscape	Cultivated, partially natural area used for agricultural production, determined by its biophysical, geophysical and cultural characteristics

Group	Sub-group	No.	Name of Indicator	Explanation
Impacts	Habitats and diversity	33	Impacts on the habitats and diversity	Total effect of agriculture at national level. It is necessary to identify environmental impacts at the local level.
	Natural source	34.1	Agricultural share in the emission of greenhouse gases	
		34.2	Agricultural share in nitrate pollution	
		34.3	Agricultural share in the utilization of water	
	Diversity of landscape	35	Impact on diversity of landscape	

Until 2009, the indicator approach to DPSIR, being an important analytical tool, was not sufficiently implemented in Bosnia and Herzegovina. The preparation of indicators for the regular reporting to the European Environment Agency (EEA) was largely based on the enthusiastic work of some individuals. Nowadays, the application of this methodology is at somewhat higher level. For example, in the Federation of Bosnia and Herzegovina there is a list of 80 defined environmental indicators (State of the Environment in the Federation of Bosnia and Herzegovina, Federal Ministry of Environment and Tourism, 2010). A part of the indicators was taken over from the Core Set list of indicators (CSI) – defined by EEA, while the rest was defined to present the specific environmental parameters in the Federation of Bosnia and Herzegovina.

The indicators in the Federation of Bosnia and Herzegovina are classified according to the following components:

- Nature – 14 indicators
- Waters – 9 indicators
- Soil – 16 indicators
- Energy – 9 indicators
- Air – 10 indicators
- Waste management – 22 indicators.

The type of environmental indicators in the Federation of Bosnia and Herzegovina has not yet been fully defined in the portions of the list of environmental indicators on the state of nature and list of environmental indicators on the state of waste management sector.

The environmental indicators of the component of nature include natural environment, biodiversity, geologic diversity, natural heritage, conversion of habitats, conversion of the primary ecosystems, conversion of the secondary ecosystems, excessive exploitation of resources, pollution, impact of climate changes on the nature, invasive species, state of public awareness, identification (ranking) of ecosystems with a high level of biodiversity, description of particularly valuable areas.

The environmental indicators on the component of *waste management* are divided into:

1. *Municipal waste*: construction of regional disposal sites, generation and recycling of packaging material waste,
2. *Industrial waste*: production of industrial waste, hazardous waste from industry, non-hazardous waste from industry, state of the environment and effects, disposal of industrial waste, waste oils (from industry and transportation), old vehicle tires (from industry and transportation), old batteries (from industry and transportation), useless old vehicles, electronic and electrical waste,
3. *Medical waste*: total amount of waste coming from medical facilities, production of hazardous medical waste, production of waste from veterinary facilities, implementation of individual methods for proper disposal of waste from medical and veterinary facilities, waste from agriculture and forestry, production of waste in agriculture – plant production.

As for the other lists (water, land, energy, air) in the Federation of Bosnia and Herzegovina, the types of indicators are defined as follows:

Table 12. List of environmental indicators on the state of land in the Federation of Bosnia and Herzegovina

No.	Land	Type of indicator by DPSIR
1	Structure of total land	S
2	Structure of urbanized land	S
Utilization of land		
3	Conversion of purpose	P
4	Annual average of the conversion of agricultural land	S
5	Level of development of the land use monitoring system	R

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No.	Land	Type of indicator by DPSIR
Protection of soil		
6	Emission into the soil	P
7	Anthropogenic and special degradation of soil	P
8	Vulnerability of soil	P
9	Soil acidity	S
10	Soil contamination by heavy metals and other chemical agents	S
11	Health state of the soil	S
12	Physical loss of the soil	S
13	Soil compaction	S
14	Structure of soil by quality classes	S
15	Level of development of the soil quality monitoring system	R
16	Forest certification – FSC	R

Table 13. List of environmental indicators on the state of waters in the Federation of Bosnia and Herzegovina

No.	Waters	Type of indicator by DPSIR
Utilization of waters		
1	Utilization of water for water supply	P
2	Utilization of water for irrigation	P
3	Utilization of water for industry	P
Protection of waters		
4	Irrigation and treatment of municipal and industrial waste waters	P
5	Emission of organic matter	P
6	Quality of surface waters	S
7	Quality of ground waters	S
8	Quality of drinking waters	S
Protection from waters		
9	Flood risk areas	S

Table 14. List of environmental indicators on the state of the energy sector in the Federation of Bosnia and Herzegovina

No.	Energy	Type of indicator by DPSIR
1	Total (domestic) production of energy in the Federation of BH	S
2	Final consumption of energy by sectors	S
3	Total energy intensity in Bosnia and Herzegovina	P
4	Total consumption of primary energy by the type of energy-generating products in Bosnia and Herzegovina	D
5	Consumption of renewable energy in Bosnia and Herzegovina	P
6	Electric energy from renewable sources in Bosnia and Herzegovina	P
7	Large furnaces	P
8	Small furnaces	P
9	Number of registered motor vehicles	P

Table 15. List of environmental indicators on the state of air in the Federation of Bosnia and Herzegovina

No.	Air	Type of indicator by DPSIR
Emission into the air		
1	Emission of acidic gases (acidifying substances) in the Federation of BH	P
2	Emission of ozone precursors CH ₄ , CO, NO _x and NMVOC in Bosnia and Herzegovina	P
3	Emission of primary particles and secondary precursors of PM ₁₀ , CO ₂ , NO _x and NH ₃ particles	P
4	Emission of greenhouse gases	P
Quality of air		
5	Production and consumption of compounds harmful to the ozone layer	P
6	Acidity (pH) of precipitation	S
7	Exposure of ecosystems to acidification of atmosphere, eutrophication and ozone	S
8	Excess of the limit values of the air quality parameters in urban areas	S

No.	Air	Type of indicator by DPSIR
9	Content of heavy metals in total floating particles	S
Monitoring		
10	Review of the air quality monitoring state	S

MILLENNIUM ECOSYSTEM ASSESSMENT (MA)

Everyone on the planet is totally dependent on ecological systems and their services. The provision of food and water, raw materials, disease control, regulation of climate, spiritual contempt and esthetic enjoyment – these are all services of the ecosystems without which life on Earth would not be possible. In the past 50 years, people have changed these ecosystems more rapidly and intensively than in any other periods of human history, mainly to fulfill their increasingly growing requirements for food, fresh water, timber, fiber and fuel. This planetary transformation has contributed to the considerable improvement of human wellbeing and economic development. However, not all the regions or all people have benefited from this process – actually, it was detrimental to many. Furthermore, the true price of such a growth has only now become apparent.

The Millennium Ecosystem Assessment (MA) conducted an evaluation of 24 ecosystem services. Within the MA, the ecosystem services are divided into:

1. Provisioning services: food, fibers, waters, genetic resources, as well as medical, biochemical and pharmaceutical services,
2. Regulating services: control of the quality of air, climate, erosion, water purification and treatment of waste, control of diseases, pests, pollination and control of natural hazards and
3. Cultural services: esthetic values (pleasure), spiritual and religious values, recreation and eco-tourism

Out of 24 evaluated services, 15 (60%) are degraded or utilized in unsustainable way. Degradation implies a reduced capacity of an ecosystem to perform its services. The ecosystem services that have been degraded in the past 50 years include net fishing of sea fish, water supply, treatment of waste, detoxification, purification of water, protection from natural disasters, air quality control, control of local and regional climate, erosion control, spiritual and esthetic enjoyment.

The most alarming situation is in the areas of sea fish net fishing and consumption of fresh water, whose levels of exploitation exceed the current level of sustainability, let alone the future one. At least one quarter of the significant commercial fish supplies is overfished, while the consumption of fresh water at the global level exceeds available supply by 5% - 25%. In addition, the extraction of water for irrigation exceeds the supply rates by some 15-35%, which cannot be sustainable.

Over the past 50 years, only 4 ecosystem services have actually been improved, and three of them are related to the food production (field crops, livestock and aquaculture), while the fourth one is related to the control of global climate through the sequestration of carbon from the atmosphere. Namely, in the nineteenth and early twentieth century, the terrestrial ecosystems were generally the pure sources of CO₂ emission into the atmosphere; however, in the middle of the last century they became the storage sites for the atmospheric CO₂.

Table 16: Global state of the food provisioning, regulating and cultural services of the ecosystems evaluated in the Millennium Ecosystem Assessment.

Service	Sub-Category	State	Remarks
Provisioning services			
Food	Crops	↑	Considerable increase of production
	Livestock	↑	Considerable increase of production
	Net fishing of sea fish	↓	Decline in production due to overfishing
	Aqua-culture	↑	Considerable increase of production
	Food in nature	↓	Production in decline
Fiber	Timber	+/-	Loss of forests in some regions, growth in others
	Cotton, hemp, silk	↓	Decline in production of one type of fibers, increase in some others
	Fire wood	↓	Production in decline
Genetic resources		↓	Loss due to extinction and depletion of the crop genetic resources
Biochemical, natural-medical, pharmaceutical		↓	Loss due to extinction, excessive exploitation

Service	Sub-Category	State	Remarks
Water	Fresh (drinkable) water	↓	unsustainable utilization of water for drinking, industry and irrigation; quantity of hydro-energy unchanged, yet dams increase the capacity for a more efficient utilization of that energy
Regulating services			
Air quality control		↓	Decreased self-purification ability of the atmosphere
Climate control	Global	↑	Largest source of carbon sequestration since the mid century
	Regional and local	↓	Prevalence of negative impacts
Water control		+/-	Varies depending on changes in the ecosystem and its location
Erosion control		↓	Increased soil degradation
Purification of water and treatment of waste		↓	Quality of water deteriorates
Disease control		+/-	Varies depending on changes in the ecosystem
Pest control		↓	Natural control degraded by the application of pesticides
Pollination		↓	Apparent global decrease of the pollinators' abundance
Control of natural risks		↓	Loss of natural buffers (wetlands, mangrove forests)
Cultural services			
Spiritual and religious values		↓	Rapid decline in sacred forests and species
Esthetic values		↓	Deterioration in quality and quantity of natural land
Recreation and eco-tourism		+/-	More areas available, but many of them degraded

The state column indicates whether in the recent past, the status of the service has been globally increased \uparrow (e.g. if the production capacity of a service has been increased) or degraded \downarrow .

The table clearly indicates a noticeable decline in production of fish due to overfishing of sea fish, which actually reflects the occurrence well known as the „fishery collapse“. Negative occurrences related to unsustainable fishing of some fish species are not limited to just depletion of the fish supply. For example, the cod fish supplies in the Atlantic near the East Coast of Newfoundland went under in 1992, resulting in forced collapse of the centuries old fishing industry. Additionally, it has to be noted that the renewal of exhausted fish supplies takes multiple years, and yet, it may happen that it never fully recovers despite the considerably reduced or even eliminated fishing.

The impacts of the loss of ecosystem services (spiritual and religious values; esthetic values and eco-tourism) are particularly hard to measure; however, they are extremely important to some people. Different cultures, systems of knowledge, religions and social interactions are largely influenced by the ecosystems. A large number of the sub-global assessments show that in many communities, the spiritual and cultural values of an ecosystem are as important as its other services, in the developing (e.g. significance of the sacred forests in India), and industrial (e.g. significance of the city parks) countries alike.

There is sufficient information about the causes of change in the functioning of ecosystems, about the effects of such changes on human well-being, as well as about the success of some measures in improving the decision making process as a support to sustainable development. And yet, due to the gaps in both information and knowledge, the ecosystem assessment could not have answered fully to a large number of questions raised by its beneficiaries. Some of these gaps are a result of the weakness of the system related to the monitoring of the ecosystem services and their relation with the human wellbeing. In some other cases, the assessment has revealed a considerable requirement for further research, e.g. to improve the understanding of non-linear changes in the ecosystem and economic values of the alternative management options. The investments in the promotion of monitoring and research, combined with additional assessments of the ecosystem services in various countries and regions, would substantially increase the benefit from every future global assessment of the effects of changes in ecosystems on human wellbeing.

Nonlinear (Gradual) Changes in Ecosystems

The changes in ecosystems generally occur gradually. However, some changes are not linear. Once the allowable threshold is exceeded, the system changes and transforms into a totally different state. There is a reasonable but insufficient evidence that the changes taking place in ecosystems increase the probability of the occurrence of nonlinear changes in ecosystems (to include accelerated, abrupt and potentially irreversible changes), with significant effects on the human wellbeing. These nonlinear changes are sometimes very abrupt; they also may be huge by their magnitude (significance), and heavy, expensive or impossible to return into their original state.

The examples of such changes include disease incidence. As example, huge floods induced by El Nino in 1997/98 caused the outburst of cholera in Djibouti, Somalia, Kenya, Tanzania and Mozambique, warming of the African Great Lakes due to climate changes may create conditions that increase the risk from cholera spreading into the neighboring countries; sudden change of the quality of water; formation of "dead zones" littoral waters; fishery collapse; introduction of species and losses, like the introduction of zebra mussel into the water systems of the United States of America led to the extinction of the autochthonous shellfish in the St. Clair lake and created annual cost to the electric power industry and other beneficiaries in the amount of \$100 million), then shifts in regional climate (e.g. deforestation which reduces the amount of precipitation which causally impacts development of the forest cover).

The possibility of predicting some nonlinear changes is getting better and better, though for many ecosystems and the majority of potential nonlinear changes, despite the fact that science can often warn about increased risk from change, it cannot predict the thresholds where the changes will be encountered.

The Millennium Assessment Scenarios

The Millennium Assessment (MA) has developed four scenarios looking into a plausible future of ecosystems and human wellbeing based on various assumptions about the change driving forces and their possible interactions. These are as follows: *Order from Strength*, *Global Orchestration*, *Adapting Mosaic* and *Techno Garden*.

These scenarios examined two paths of global development: one, according to which the world is becoming more and more globalized, and second, according to which it is becoming more regionalized. It additionally addresses two different approaches to managing the ecosystems. The first one addresses the measures (ac-

tivities) that are reactive and where most problems are tried to get resolved only after they have become apparent, and the second, in which the managing of the ecosystem is proactive (aggressive, preemptive) and in which policies try to wisely and in the long run maintain the ecosystem services.

Three scenarios – *Global Orchestration*, *Adapting Mosaic* and *Techno Garden*, include some significant changes in policies aimed at addressing the challenges of sustainable management. In *Global Orchestration*, trade barriers are eliminated, inadequate subsidies abolished, and the main emphasis placed on eradication of poverty and famine. In *Adapting Mosaic*, by 2010, most countries will spend nearly 13% of their GDP (gross domestic product) on education (relative to the average of 3,5% in 2000) while the institutional agreements on transfer of skills and knowledge among the regional groups will get multiplied. In *Techno Garden*, policies are established that will ensure that individuals and companies are paid for rendering or maintaining the ecosystem services. For example, according to this scenario, by 2015 about 50% of the European agriculture and about 10% of the North American agriculture will be directed toward bringing into balance the food production and other services of ecosystem. According to this scenario, there will be a lot of improvements in developing environment friendly technologies that will increase the production of services, create substitutes and reduce detrimental concessions.

In each of the four MA scenarios, the predicted changes of factors result in:

- *a considerable growth of consumption of the ecosystem services* (requirement for food crops will increase by 70-85%, while requirement for water will increase by 30-85%);
- *a continuous loss of biodiversity* (globally, the scenario foresees that the balanced number of plant species will be diminished by roughly 10-15% due to loss of habitat alone in the period from 1970 to 2050 (low level of security), while other factors such as excessive exploitation (harvesting), invasive species, pollution and climate changes, will cause further increase of the extinction rate);
- *further degradation of some ecosystem services* (first and foremost in the freshwater ecosystems: reduced aquatic habitats, fish production, and water supply to the houses, industry and agriculture).

According to the MA scenarios, food security will not be reached, nor will malnutrition of children be eradicated by 2050 (some scenarios even predict its increase in certain regions), despite the increased amounts of food and its diversification.

The most important **direct factors of change** in ecosystems include:

- change of biotope (change of the land use method, physical modification of rivers or withdrawal of water from rivers),
- excessive exploitation,
- invasive alien (non-autochthonous) species,
- pollution, and
- anthropogenic climate change.

These direct factors often act together. For example, utilization of land in some areas may cause an increased accumulation of nutrients (if the land is converted into a highly intensive agricultural land), increased emission of greenhouse gases (in case of deforestation), or invasion of allochthonous species (due to disturbed habitat).

- *Transformation of biotope*, especially the one caused by conversion of land into agricultural land: The MA scenarios foresee that another 10-20% of pastures and forest land will be converted into land with different purposes (primarily agriculture) between 2000 and 2050. The predicted conversion of land is concentrated in the countries with low income and large dry areas. It is estimated that the forest cover will continue to grow in industrially developed countries.
- *Excessive exploitation*, particularly overfishing: in some marine systems the fish biomass required by fish industry (to include targeted and accidentally fished species) has reduced by 90-99% relative to the pre-industrial levels, while the fish catch ever increasingly and more often comes from the categories of nutritionally less valuable species as the populations of species having higher nutritive value are already exhausted. Such pressures continue to increase in all MA scenarios.
- *Invasive alien species*: Spreading of invasive alien species of organisms which cause diseases still rises due to deliberate relocation, as well as accidental introduction related to the ever growing rate of trading and traveling, which has huge negative impact on native species and many ecosystem services.
- *Pollution, particularly the accumulation of nutrients*: Humans have already doubled the rate of outflow of reactive nitrogen on the continents, while some estimates say that this growth will continue by approximately two thirds by 2050. Three of four MA scenarios predict that the overall flow of nitrogen in coastal ecosystems will increase by another 10-20% by 2030,

given that almost entire growth will occur in developing countries. The excessive outflow of nitrogen contributes to the eutrophication of fresh water and littoral maritime ecosystems, as well as to acidification of the fresh water and terrestrial ecosystems (with effects on biodiversity in these ecosystems). To some extent, nitrogen also plays an important role in the formation of tropospheric ozone at ground level (which leads to the loss of agricultural and forestry productivity), depletion of ozone layer in stratosphere (which leads to the depletion of ozone layer and increased UV-B radiation on the Earth, causing thus a higher incidence of skin cancer), as well as climate change. The health related effects include the effects of ozone pollution on asthma and respiratory functions, increased allergies and asthma caused by elevated production of pollen, risk from the «blue baby» syndrome, cancer and other chronic diseases caused by the presence of nitrates in drinking water, increased risk from a range of lung and heart diseases caused by production of fine particles in the atmosphere.

- *Anthropogenic climate change:* The recent climate changes, especially the higher regional temperatures, have already made a significant impact on biodiversity and ecosystems, to include the induction of change in distribution of species, size of populations, time of reproduction or migration, as well as increased incidence of diseases and pests. Many coral reefs (unique habitat to sea animals) sustained a significant, though partially reversible bleaching, when the surface temperatures in one month raised by 0.5-1 °C above the average for the warmest months.

By the end of the century, the climate changes and their impact may be a direct factor (driving force) in biodiversity loss and global change of ecosystem services. The scenarios developed by the Intergovernmental Panel on Climate Change (IPCC) predict a growth of the mean global air temperature by 2.0-6.4 °C relative to the pre-industrial level by 2100, increased occurrence of floods and droughts, and rise of the sea level by additional 8-88 cm between 1990 and 2100. Damages thus caused to biodiversity will continue to grow around the world, as well as the rate of climate changes and absolute amount of change. On the other hand, some ecosystem services in certain regions may initially experience some improvement due to predicted climate changes (e.g. increase of temperature or amount of precipitation), gaining thus benefits at the lower levels of climate change. But as the climate change became more pronounced and larger, detrimental effects would prevail over the beneficial ones in most regions of the world. The overall scientific evidence indicate that the total damages to the ecosystem services will be considerable, if the global ground level temperature rises by more than 2 °C relative to the pre-industrial level, i.e. if its growth rate is higher than 0.2 °C per decade. There is a broad area of

uncertainty when it comes to the amount of warming that will result from any stabilized concentration of greenhouse gases, however, based on the IPCC projections, this is going to require that possible level of CO₂ be stabilized at less than 450 ppm.

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