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THE AGE OF ECOLOGY AND FORESTRY – CHALLENGES AND THREATS

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Abstract: Apart from being a natural resource, the environment can be a limiting factor for a number of economic and social processes. It is not disputed that certain damage cannot be avoided and some environmental degradation can be tolerated. However, it is necessary to determine the breakpoint in the exploitation of the natural heritage of the Planet. Forestry is finding its place in the world of science and other important human activities. Environmental ethics has become an intrinsic part of the forest research in this century. Having recognized negative consequences of the former mono-functional, industrial forestry, which largely overlooked the integrity of forest ecosystems, the principles of integrated, multi-functional forestry have been established. The indisputable interdependence and coherence of all forest benefits prove that only professionally managed forests can provide multiple-use forest benefits. Today's forestry faces complex tasks created by modern developed societies. Forestry, *i.e.* forest resources, is expected to meet the requirements at three different levels: biosphere, bio-ecology and socio-economy. In order to achieve this, it is necessary to put in a great deal of effort to *harmonize natural* mechanisms and *human activities*, without overlooking environmental and social responsibilities of modern civilization.

Keywords: the environment, forestry, forest benefits

1. IMPORTANCE AND BENEFITS OF FOREST ECOSYSTEMS

Today, forests are the largest terrestrial ecosystems on Earth and as such they make 'environmental pillars' of the ecosphere. They cover 40.6 million square meters, which is 8% of the Earth's area or 28% of its land area. Regarding the global biological production, forests have an indisputable quantitative and qualitative advantage over other ecosystems. Forest ecosystems produce about 33% of the total organic matter. Biological and production processes last far longer in forests than in aquatic ecosystems, which, by its nature and distribution, can be compared with forests. Therefore, the effects forests exert on the ecosphere per unit of their area significantly exceed the effects of other macro-ecosystems - aquatic, steppe and meadow, artificial, urban, agricultural, desert and semi-desert. Considering the effects on the surrounding environment, one hectare of forest equals 6-7 hectares of seas and oceans, 3-4 hectares of steppes, meadows, and pastures, 23-25 hectares of semi-deserts.

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It all shows that forests have more stable and active effects on the overall production and cycling of organic matter in the nature than other ecosystems, and compared to all other ecosystems, both terrestrial and aquatic, they have the most active participation in the global and regional biogeochemical cycles. These facts prove the vital importance of forests as the Earth's natural heritage, reflected in the provision of a wide range of benefits (figure 1). These benefits, as specific scientific, technical, environmental and social categories are the achievements of the urban-industrial civilization and make the basic postulates of the modern forestry science. The long time period that preceded the civilization of this century can be considered as the epoch of mono-functional forestry, in which the research studies of forests focused on auto-ecology of tree species and forest cultures, dominated by direct material benefits of forests (wood, game, forest berries, grazing, etc.). Other forms of forest utilization were not widespread.

Figure 1. Teaching Base '*Majdanpečka domena*' of the Faculty of Forestry in Belgrade

The Industrial Age brought multifunctional forestry which, apart from material forest benefits, took into account a number of non-material needs that the forest as a natural resource could fulfill. This new 'type' of forest was established as a multifunctional category and it was caused by urban development and rapid deterioration in the living conditions in these areas. The concept of multi-functional eco-forestry originated in developed countries as an alternative to the crude and anthropocentric industrial forestry. Wood volume and assortments are

no longer taken just as 'crop yield`, and a forest professional is not just a 'farmer' working in forest plantations. Clear-cutting is prohibited by law. The recent inflow of new information, brought about by the rapid development of fundamental and applied ecology, was crucial for the adoption of new approaches to understanding the value and using the resources of forest ecosystems. The turning point in the recognition of multiple-use forest benefits came with *The Multiple Use Sustained Yield Act,* passed by the US Congress in 1960. The law introduced the principle of multifunctional forest management into state forests. Recent advances in environmental science opened new perspectives on the complexity of the structure, benefits and development of forest ecosystems, understanding of biodiversity, the role of forested catchments that accumulate water and regulate water regimes, landscape and urban ecology, etc. According to Velašević, V., Đorović, M. (1998), the relevant literature uses the following terminology for these benefits: *Social Benefits, Environmental Benefits of Forestry, Non-Wood Producing Function of Forestry* (USA, Great Britain); *Die Sozialfunktionen des Waldes, Wohlfahrts-wirkungen des Waldes* (Germany); *Les fonctions de la foret, Les avantages des forests pour l'environmnet* (France); *Oūшче йолезние функции леса* (Russia); *Obcne užitožne funkce lesa, Spolecenske funkce lesa* (Slovakia). The concept of the term `multiple-use forest benefit` varies with time, authors, environmental and socio-economic conditions. The most commonly used definition was given in the early 20th century by Endres within the term Wohlfahrtswirkungen, which defines '*.... the impact of forests on climate, water management and agriculture and its effects on human well-being in terms of a hygiene and aesthetics.'* Mantel emphasizes the sociological content of the term and distinguishes its four aspects: 1) physical and political benefits of forests as the basis of popular culture; 2) forests as a part of national economy; 3) labor-social and 4) socio-political functions. Zahar, D. (1984) proposes a general diagram of the environment in which forests and forestry occur as a component of the subsystems of biosphere, technosphere, humanosphere and so on. Experts from the FAO/ECE (1974) provide the following definition of multiple-use forest benefits: *'Forests are essential constituents of the environment in general and of human livelihood. Their role involves different aspects of the use and management of forests: 1. the impact of forests on climate, air, water and soil; 2. the role of forests in preserving the biological heritage within forest ecosystems; 3. social service in landscape management and recreation.'* Biterlih classifies all forest functions into five groups: 1. wood production; 2. non-timber forest products; 3. water regime regulation; 4. protective functions; 5. other direct and indirect benefits, noting that the list needs to be expanded. During the further development of forest-related scientific disciplines, 45 forest functions have been determined, 30 of which belong to the category of multiple-use forest functions and 15 to production forest functions (Papanek, F., 1972).

The importance of the **economic functions** of forest ecosystems lies in the production of wood at the global level, taking into account the diversity of forest ecosystems and different productive capacity of different forest sites. Economic benefits of forest ecosystems are reflected in the wide use of wood as a raw material in a large part of the world industry and other economic sectors. It is believed that there are over 13,000 products derived from wood. It is also important to mention

the production of non-timber forest products: resin, bark, forest seeds, game and other forest fauna, wild berries and herbs, edible forest fruits, raw materials for the cosmetics industry and others. Another important aspect of the economic forest function is biomass production and maintenance of the balance of oxygen and carbon dioxide in the air. Besides the amount of dry substance and absorbed amounts of carbon-dioxide, the amount of stored carbon is another important and accurate indicator of the productivity of ecosystems. High potentials of forest resources, reflected in the global carbon cycling, can be expressed in monetary terms through the price of one ton of CO_2, which according to the Emission Trading Scheme amounted to 39 € in 2012 (http: www.platts.com).

Protective functions include a range of forest benefits, such as: protection from erosion, impact on climate, protection of water resources and water regulation, air protection, emission reduction, *etc*. The role of forests in the protection from erosion is reflected in their ability to form a dead plant litter which reduces the effects of pluvial soil erosion in the initial phase of erosion. Middle-aged forest complexes produce about 3,000 kg of dead forest litter per hectare annually and thus form an 8-9 cm thick layer of organic matter (Bunusevac, T., 1951). This process protects the soil from the impact of raindrops (*splash erosion)*, regulates the surface runoff, allows the infiltration and reduces the risk of flooding, improves the soil structure and thus significantly increases the gravitational water capacity (Đorović, M. *et al*., 2003). The flexible and wide-spreading root system of woody species, with a large mass of fibrous rootlets, increases the soil binding capacity, firms the soil to the bedrock and thus prevents erosion. By creating a powerful soil profile, overall physical and chemical characteristics of the soil in extremely poor sites are improved, which results in increasing productivity of the sites. The positive erosion protection effects of forests contribute to amelioration and rehabilitation of the most endangered terrains.

As important water conservation agents, forest ecosystems play a crucial role in the regional and global hydrological cycle. Their numerous functions not only regulate water balance, but also define the regime of runoff in forested drainage basins. The effects of forests, in this respect, are the following: increasing the total water yield by reducing surface runoff, retaining, absorbing and converting rainfall into the subsurface and groundwater flows, providing permanent supply of water to water sources, flood and erosion mitigation, especially in extremely difficult terrains. Forests also play an important role in precipitation filtering and have significantly positive impact on the quality of the water that flows down the forest area. The afore-mentioned points to a strong compatibility of anti-erosion, hydrologic and water protection functions of these anthropogenic ecosystems. According Velašević, V., Đorović, M., 1998; Velašević, V. *et al*., 2002; forest stands retain large amounts of water during rainfall - more than 30%, which is more pronounced in coniferous stands because they have denser canopies and retain foliage throughout the whole year. The proportion of the intercepted water depends on the structure, density and age of the stand. Concerning the runoff and retention processes, a number of authors state that the ability of forests to retain large amounts of water depends on the physical properties of soil or its maximum water-holding capacity. Thus, the porosity of forest soil (air holding capacity) plays

a major role in reducing the rapid surface runoff and the process of infiltration. According Biščević, A., 1971, 1 m^3 of pine needles in forest litter retains 160 liters of water. The forest litter in pure pine stands is capable of infiltrating up to 8.5 mm of water. At the same time, forests are not big water consumers. According to Pintarić, K. 2004, Scots pine stands, annually consume 336 m^3 of water per hectare while stands of spruce and beech of the same age, consume up to 1,600 m^3 of water per hectare. According to the same author, it takes about 400 liters of water to produce 1 kg of dry substance of beech wood and only 116 liters for the production of pine wood.

As an important climate modifier, forest ecosystems mitigate the effects of single or multiple climate factors. Furthermore, they are one of the most reliable indicators of climate conditions. Their ability to decrease air temperature and increase condensation of absolute and relative humidity, retain atmospheric precipitation, increase the cloud cover, reduce the velocity and power of winds and regulate the air composition and the oxygen balance in it, makes forests important regulators of the climate and protectors of micro- and macroclimate on a global scale. Research studies conducted in Central Europe (according to Medarevic, M., 1991) show that middle-aged pine stands have the air temperature lower by 1° C and soil temperature on average by 3.2° C than their immediate surroundings. The annual fluctuations in temperature, relative air humidity and soil moisture is significantly lower in the forest than in its immediate surroundings. It should be noted that the influence of forest areas on the amount and frequency of rainfall is not significant. According to most researchers, this influence can be as high as 10%. However, trees are significant accumulators of air humidity since plants covering one hectare of forest release 3,000 m^3 of water each year into the atmosphere, which corresponds to 300 mm of atmospheric precipitation (Bunusevac, T., 1951).

Air protection and emission reduction is a forest function based on a scientifically proven fact that forests, annually, filter out 50-70 tons of dust per hectare, with the process taking place not only in the forest, but also at some distance from the edge of the forest. The area of assimilation organs is made of tens of thousands of leaves to over hundreds of millions of needles of woody species per hectare. These green leaf oceans act as a global air filters and air conditioners (Vukin, M. *et al*., 2013; 2014). Conifer stands (figure 2) release 5 kg/ha of volatile organic substances with phytoncide effects into the atmosphere both during the day and at night. These are easily volatilized oils, such as terpenes, isoprene, pinene, and balsams, which have positive effects on the respiratory system. On an annual basis, depending on the type of forest, this amount of 'air vitamins' can total up to several thousand kilos per hectare. Many species of trees, such as Scots and Austrian pine (Vukin, M., Bjelanović, I., 2009), Japanese and hybrid larch, Serbian spruce (green belts around London) show very high resistance to air pollution and are often used in urban landscaping and for building green belts, windbreaks and shelterbelts.

Figure 2. Nature Park 'Šargan – Mokra gora'

Social functions of forests include: health and safety, recreation and tourism, aesthetic value, noise protection, education, scientific research (figure 3) and many others. These categories of multi-use forest functions have been developed as inevitable achievements of industrial, urbanized and high-tech civilization. These are generally socio-economic functions, but considering their abundance they can be classified into different groups and studied from several different aspects. Modern science recognizes more than a hundred forest functions, including so-called ecoistic (urban), religious (spiritual ecology) or aesthetic functions, and numerous other non-timber or indirect benefits from forests. A more detailed elaboration of these functions would probably call for a whole new chapter in this brief overview of the challenges of modern forestry.

Forestry science has confirmed its initial principles upon which the use of forests, from a biological point of view, must be incorporated with their restoration, tending and protection. Thus, the concept of *sustainable forestry* involves sustainability of revenues and fulfillment of numerous functions of forests. Foresters claim that forests can and should be used, but only in the ways that improve their condition. New approaches have been introduced to this very important branch of economy and field of science which relies on the broad knowledge developed within ecology.

Figure 3. Special Nature Reserve 'Goč-Gvozdac' and Teaching base 'Goc', Faculty of Forestry in Belgrade

2. ENVIRONMENTAL CRISIS AND THE CENTURY OF ECOLOGY

2.1 The environmental crisis - a planetary scale

Along with the development of the scientific approach to multi-functionality of forest ecosystems, the threat to the entire environment and the need to protect it are constantly increasing. New concepts are developed and defined: biodiversity, sustainable development, monitoring, greenhouse gas emissions, emission allowances, carbon footprint, acid rain, monoculture, invasive species, GMO and bio-engineering, green projects and 'Green-washing', ecosystem services, environmental migrants, permaculture etc.

The industrial societies in the 19th century radically changed social relations, as well as their relationship to nature. They entered an era marked by deeper and more comprehensive knowledge about the nature on the one hand, and drastic exploitation of all its components on the other. In the spiritual sphere, this condition was best described by Witehead, A.N., (1976): *'The passwords of the nineteenth century included: struggle for existence,, competition, class struggle, trade rivalry, military conflict. The struggle for existence was interpreted as a gospel of hate*' Vladimir Vernadsky, Russian mineralogist and crystallographer warned his contemporaries as early as the twenties of the 20th century that the growing

human power can change the face of the Earth, for better or for worse. How right Vernadsky was can be seen in human achievements attained during the 20th century, shortly after his warning. In just a few decades after the information revolution, our planet was faced with a global ecological crisis. Commoner, B. (1990) explained the relationship between the ecosphere and the technosphere in the following way: *'It is necessary to understand the interaction between our two worlds: the natural ecosphere, a thin global belt made of air, water, soil, plants and animals that live in it and the human technosphere that has become so large and intense that it can change the natural processes that sustain the ecosphere. In turn, the modified ecosphere brings floods to our cities, drought to agriculture and hinders the production of food, contaminating our food and water, poisoning our bodies - disastrously reducing our ability to meet human needs. The human attack on the ecosphere has caused environmental counterattack. THE TWO WORLDS ARE AT WAR.*

This serious problem of the so-called 'sixth biological crisis of the Planet` has been the issue of numerous scientific research studies and projects. However, a lot of other authors have recognized and written about this global environmental threat. The 'green revolution' was started by Rachel Carson, an American journalist, in 1962. She published the book *'Silent Spring'*, in which she strongly and clearly condemned the sudden and uncontrolled rise of the post-war technology and the use of DDT for agricultural purposes in the USA. Several decades before this, North America had been hit by one of the first ecological disasters caused by man. The *'Dust Bowl'* was a consequence of enormous devastation of natural ecosystems and their conversion into agricultural land. During the severe drought of the 1930s, this drained soil was exposed to disastrous dust storms and blizzards which destroyed millions of hectares of agricultural land and forced hundreds of thousands of people to abandon their homes. This catastrophe was best described in the classic novels by John Steinbeck, "*The Grapes of Wrath*" and "*Of Mice and Men* '.

Leszek Kolakowski, Polish philosopher, who left the country for political reasons, wrote about the undermined foundations of modern civilization. His famous essay "*The Devil and Scripture*, *The Key to Heaven and Talk of the Devil*', published in 1983, stresses the need to change our attitude towards the Nature, and that '*.... the man as an undisputed master, a ruthless user and destroyer of natural resources, enthroned in the name of Jewish and Christian theology, should accept the invitation of his friend and partner – The Nature.'* In the late 20th century, the Norwegian philosopher Arne Naess laid a foundation for environmental philosophy, by publishing the essay *The Shallow and the Deep Long-Range Ecology Movements,* 1973. The concept of eco-philosophy was further elaborated by Deval, B. Sessions, G. in the book `*Deep Ecology*`, 1985). Another work of art speaks of the growing planetary ecological crisis. The documentary *'Darwin's Nightmare*' points out far-reaching adverse effects of stocking the largest tropical lake in the world - Lake Victoria in Africa, which was done in the 1980s. The introduction of invasive species has disturbed the natural balance of this invaluable aquatic ecosystem and strongly affected the life and economy of the local population and the whole region (www.ceeweb.org).

Extinction and disappearance of hundreds of plant and animal species has acquired planetary proportions. Habitats disappear altogether, human existence is threatened. Since 1990, over 50% of the world's wetlands have been lost, while over 35% of coral reefs are at risk of species extinction. The extent of the human influence on today's loss of biodiversity is clearly shown in the fact that out of 1,747,851 scientifically recognized species, 44,838 species around the world are threatened. Of this number, 16,928 species (38%) are facing extinction, and 4,770 species are highly threatened (IUCN, 2010). According to the Red List of The *International Union for Conservation of Nature* (IUCN - The IUCN Red List, 2013), 799 species have disappeared since the 19th century. Furthermore, according to the International Union, apart from the species that are critically endangered, 1/4 of all mammal species, 1/8 of all bird species, 1/3 of all amphibian species, 1/3 of all angiosperms and 2/3 of all gymnosperms are fighting for their survival. Modern science has estimated that there are 14 million species in the world today, most of whom have not been described yet. According to the rate of their extinction, we can conclude that 27,000 species disappear every year, *i.e.* 74 species a day. Due to the rapid human population growth and the current rate of biosphere destruction by man, the rate of species extinction at this moment is about 1,000 times higher than the natural extinction rate. Taking into account the current rate of species disappearance, Wilson, E. Fr. (2005) estimates that if this trend continues, half of all modern species will disappear from the face of the Earth in less than a hundred years. Therefore, there is a general agreement among scientists that the planet is facing the sixth mass extinction of species. Unlike previous five, when the extinction was caused by global natural changes, the ongoing Holocene mass extinction of species has resulted from human-caused changes. It became clear that while rushing to assert their rights, humans in the last two centuries stumbled on their commitments to nature. There is no doubt that the collapse of the global biosphere has already started! As early as 1990, Miller called the modern time 'Holocene mass suicide of humanity`.

2.2. Environmental protection – the concept and ecosystem planning

All these concerns gave rise to the environmental movement. The modern concept of nature and environment protection involves the protection and promotion of the vital elements of biodiversity and ecologically valuable ecosystems and landscapes, sustainable use of natural resources that can meet financial, health, recreational and cultural needs. Ecosystems are "fragile" systems that keep us alive and the growing awareness of our dependence on nature encourages new efforts to prevent their destruction.

Science has shown that if we want to save endangered species and maintain healthy landscapes, we must protect entire ecosystems rather than just individual species. If we want to preserve soil, water and living beings, it is necessary to manage them as a whole, with the help of "ecosystem planning." In turn, ecosystems provide their priceless services, such as regulation services, supply services, support services, spiritual services and health and recreational services (Amidžić, L., 2014).

Passive and active measures of biodiversity protection have been established

at global, regional and local levels. The lists of threatened species essential for biodiversity conservation (so-called Red Lists) are released, protected natural areas are designated, ecological networks are established to connect protected areas important for biodiversity conservation with other types of smaller, spatially distant and fragmented habitats. In the late 20th century, the international community launched a series of initiatives and actions to protect the natural heritage of the Planet. T*he United Nations Conference on the Human Environment,* held in Stockholm in 1972, marked a turning point in the attitude of the international community towards environmental issues. It was the first major international conference dedicated to the preservation of the environment and safe future of humanity. The meeting agreed upon a Declaration containing 26 principles concerning the necessity to preserve the environment and natural resources with the emphasis on integrated planning and rational development, use of science and technology, environmental education, development of national legislation and international cooperation. After the conference, *The World Conservation Strategy, Living Resource Conservation of Sustainable Development* was enacted by the *International Union for Conservation of Nature - IUCN, The World Wildlife Fund for Nature - WWF and The United Nations Environment Programme - UNEP.* Shortly after the conference, t*he World Commission on Environment and Development – WCED* was established in 1983. The Commission has developed a powerful political concept of sustainable development. One of the achievements of the Commission was the report 'Our Common Future'. The report states that economic development cannot be stopped, but it must fit into the ecological limits of the planet. It was followed by The United Nation Conference on Environment and Development, held in Rio de Janeiro in 1992, and adoption of the UN Declaration (*Rio Declaration UN, UNCED*) aimed at establishing balanced global partnership and cooperation. The Rio Declaration was adopted together with Agenda 21, The action plan for the 21st century, the Convention on Biological Diversity - CBD, the United Nations Framework Convention on Climate Change - UNFCCC and Sustainable forest management - SFM. Global commitment to halt the loss of biodiversity was once again confirmed in the city of Nagoya, Japan, in 2010, at the tenth meeting of the State Parties to the Convention on Biological Diversity. The parties passed the so-called Aichi biodiversity targets for the period 2011-2020, which established five strategic goals for biodiversity conservation. One of the goals to be achieved by 2020 was to stop the extinction of endangered species and to reduce the rate of loss of natural habitats or where possible to bring it close to zero. Supporting the Aichi targets, the UN General Assembly declared the period 2011-2020 the UN Decade of Biodiversity. The resolution was adopted at the 65th meeting held at the end of 2010.

Besides these documents regulating bilateral and multilateral strategic principles and directions of the actions related to the global nature protection, the following international agreements have been adopted: The Convention on Wetlands, Ramsar, Iran, 1971, The Convention on International Trade in Species of Endangered Wild Fauna and Flora, Washington, 1973), The Convention on the Conservation of European Wildlife and Natural Habitats, Bern, 1979), The Convention on the Conservation of Migratory Species of Wild Animals, Bonn,

1979) and The Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters, Aarchus, 1998). In 2001, The European Union made a strong commitment to protect biodiversity and stop its loss by 2020. Therefore, *NATURA 2000* was established with the aim of conserving wild flora and fauna and their natural habitats within EU. This ecological network was established under the *Habitats Directive* (Council Directive 92/43 / EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora) and the *Birds Directive* (Council Directive 79/409 / EEC of 2 April 1979 on the conservation of wild birds), which represent the most specific regulations aimed at preserving valuable habitat types and species in EU countries. The states are obliged to coordinate their activities in preserving nature regardless of their administrative and political boundaries. NATURA 2000 is a network of over 26,000 protected areas in 27 European countries and covers an area of about 117,000 hectares. For European countries that are not EU members, The Emerald Network was established in 1998. It was launched by the Council of Europe, as part of its work under the Bern Convention. It is made up of Areas of Special Conservation Interest - ASCIs in the territory of all Parties to the Convention. It extends from the Canary Islands to the Caucasus and from Turkey to Lapland, and operates in parallel with NATURA 2000 (Stojanovic, V. *et al*., 2015).

Strategic foundations of particular importance for biodiversity conservation at national and local levels are contained in national strategies for sustainable development and sustainable use of natural resources, spatial plans of individual countries and the relevant laws and regulations. Active protection of biodiversity involves complex procedures requiring high expertise in the field of biology, ecology and distribution of species, knowledge of ecological characteristics of their habitats and populations, interactions among species, factors threatening populations and habitats, as well as applicable methods of preservation. These are *in-si*tu and *ex-situ* conservation methods, reintroduction and introduction, methods of *in-vitro* propagation and collection of live material into the so-called. *Gene bank*.

2.3 Forest ecosystems in the age of ecology

Due to the interaction of complex factors, mostly human-related, recent natural vegetation of the Earth's forests has been changed dramatically, in many areas, even devastated. The balance between plant communities has been disturbed in the near or distant past. The old primeval forest communities, which have mostly remained only in traces, have undergone certain changes in their structure, microclimate, and soil. In other words, there has been a certain degree of regressive succession, followed by habitat modification and cultivation. Therefore, today we can speak of restoration of forest communities in the substantial part of our planet, or of potential natural vegetation to be developed in further progressive succession if we, theoretically, exclude any human activity.

The worrying state of the Earth's forest ecosystems is particularly reflected in the vulnerability of the global biodiversity, given that the forests of tropical, subtropical, temperate and boreal belts account for the largest part of the total

genetic, species and ecosystem diversity of the planet. Disappearance of some forest plant and animal species has reached pandemic proportions because these processes are no longer affecting individual species, but whole ecosystems. Under the influence of a series of biotic and abiotic factors, the immune mechanism of certain ecosystems has lowered to the level that forest species that act as holders of biocoenoses are no longer able to withstand the increasing number of stresses that act simultaneously for a longer period of time affecting large areas.

Nowadays, large areas of forests have been to a lesser or greater extent destroyed and converted into agricultural and urbanized ecosystems or they are in various stages of degradation. According to *FAO Commission of Forestry* reports, a period of only one decade in the second half of the 20th century (1979-1989) saw destruction of 142,000 km^2 of tropical rain forests. This process continued at an alarming rate. According to other estimates made at the end of the 20th century, about 230,000 km^2 of forests disappear every year, which is roughly the size of England, Scotland and Wales. According to Tesar, J. (1991), since the beginning of 1990 the world's forests have been disappearing at a rate of 32 hectares a minute!

Centuries of destruction and overexploitation of forests have been followed by erosion processes, desertification, acidification, salinization, destruction of wild and untouched landscapes and 'pristine' forests, climate change, forest fires, forest decline, drastic reduction of biodiversity. On the other hand, there are negative effects of socio-economic factors and the current world economic crisis, together with the adverse effects of improper management in the past, supremacy of industrial forestry and formation of even-aged forest monocultures. Furthermore, the problems concerning the control of forest resource uses and establishment of appropriate legal jurisdictions, frequent conflicts with a number of other economic sectors - industry, water management, agriculture, tourism, transport as well as environmental issues with some streamlines of the 'green' movement have produced a number of 'threats' and challenges and urged modern forestry to respond promptly and adequately to these challenges.

3. CHALLENGES AND THREATS TO MODERN FORESTRY

The problems are undoubtedly complex. The current state of forest ecosystems on earth has caused growing concern for their survival and development, both with scientists and experts and among general public. Past trends in the use of renewable natural resources have proved to be unable to preserve the integrity of natural forests in terms of biodiversity and ability to adapt to current changes, particularly to severe climate fluctuations. In addition to the negative impact of different biotic and abiotic factors on the recent forest ecosystems, modern forestry faces a number of controversial criticisms and doubts made by the general public or some institutions about its basic ecological and biological positions. Forestry is, to a certain extent and in certain situations, still being accused of reducing forest resources to their commercial potential whose use is focused on technological and industrial processes.

The effects of widespread concern about forest condition are not always positive and rational! Excessive involvement of politicians and other non-professionals,

who are not familiar with the complexity of forest ecosystems and their roles and functions, in addressing environmental issues has often created negative attitude of society towards the forestry profession in the past few decades. With the aim of protecting forest as much as possible, certain segments of the general public have united in their opposition to the exploitation of forests, and accordingly to economic functions of forests (Nikolic, S., Stojanović, Lj., 1991).

The backbone of this problem, which has been imposed by both non-professionals and professionals from forestry-related sciences, is the issue of forest conservation - or integrated forest management. Certain social and even scientific groups are expressing the following dilemma: should forest ecosystems be left to spontaneous development without any human influence, and thus conserve the present state - OR NOT? The advocates of this standpoint state that such forest ecosystems, which have features of 'pristine' natural forests or primeval forests, are the most stable ecosystems and, as such, can provide multiple and complex forest benefits.

However, this assumption is wrong. The part of forest science related to this field has proved the opposite. The economic value of forests that develop with no human impact is negligible, but the other functions of these ecosystems are degraded, above all regulatory and safety functions. On the other hand, in defense of economic component of forestry, it should be stressed that human society cannot be denied the right to use natural resources, but it must involve a complex system of measures and models of use, as well as reasonable limitations (Velašević, V., Đorović, M., 1998). There is no alternative. The forest is exhaustible but also renewable, biological or dynamic natural resource. Sustainability of its use depends on its management, and the dynamics of its exploitation must balance the time needed for its regeneration. Controlled human operation is essential and necessary in a unique and complex system of silvicultural activities: from maintenance, regeneration, establishment to protection and use of forests. In such a system, felling is not a threat to forests, but a part of scientifically-based tending measures and systems of restoration of forest complexes, especially in the forests that are categorized as commercial forests. At the same time, felling is an essential element of forest management. Successfully performed fellings as tending measures speed up the process that occurs in the natural development of forests - nature itself selects a number of young individuals whose survival is determined by their genotype and environmental conditions. In this struggle of woody species for living space, the man has recognized the opportunity to intervene with the aim of encouraging his own survival and progress. By removing depressed trees and trees with bad phenotypic traits, we allow the development of desirable individuals, so-called 'future trees' or `function holders' and enable the development of stable forest ecosystems. Silvicultural goals are aimed at economical growth of forest. Tending measures are applied to maintain and improve the stability and productivity of a forest, ensure timely regeneration and control its development at all stages, all with the aim of achieving the global goal: deriving the greatest direct and indirect forest benefits. One of indirect forest benefits in environmentally-conscious and sophisticated contemporary society is the preservation of genetic, species, ecosystem and landscape biodiversity.

Economy and ecology are not in conflict. The task of science in the age of ecology is to find ways to develop integrated forestry, eco-forestry, and modern forestry. Identification and evaluation of forest functions should not be taken as a sign of professional, scientific, educational prestige, without considering the real interests of the mankind. Frequent overstatements have done more harm than good to forestry profession, to forest science, and to the general interest of the community and inflicted unnecessary conflicts with the forestry sector.

Apart from these controversies, modern forestry is faced with another problem: distribution of forest benefits from forest resources which are managed by other economic and social structures (tourism, transport and infrastructure, mining, industry, local governments, etc.) and as such do not belong to the regular forest management. The problems of illegal and excessive use of forest resources, trade in plant and animal species and 'green projects' which offer only short-term solutions to ecological problems are the consequences of the global economic crisis and produce socio-economic issues and deficiencies at local, national, regional and global levels. All these problems often lead to decisions that result in the loss of forest biodiversity and deterioration of forest ecosystems.

4. INSTEAD OF A CONCLUSION

The threat of further degradation and devastation of forested areas caused by a synergic action of a number of adverse factors and the vulnerability of the entire biodiversity represent one of the most important aspects of the global environmental crisis. The former industrial, mono-functional forestry ignored the integrity of forest ecosystems and the dualism of material and immaterial benefits of forests. It further created a conflict between protection and use of forest resources. Lack of knowledge and data about forest functions has impaired the quality of forest resource use.

The indisputable interdependence and coherence of all forest benefits prove that only professionally managed forests can provide a higher quality of multiple-use forest benefits. Today's forestry faces complex tasks created by modern developed societies. Forestry, *i.e.* forest resources, is expected to meet the requirements at three different levels: biosphere, bio-ecology and socio-economy. In order to achieve this, we need a consensus between foresters, environmentalists and national economy planners. Conflicts usually arise over putting the requirements in order of priority. Environmentalists insist on: distinguishing between special-purpose forests and forests of special significance, maximum biodiversity conservation, reducing the felling volume or complete conservation of the current state of some forests. Some forestry experts and economic planners focus on meeting the needs of the timber industry, export of wood and some short-term economic effects, supported by certain political structures. It is a responsibility of the society as a whole to take a deeper insight into the complex dynamics of forest ecosystems and to apply the acquired knowledge. Problems usually arise not because such knowledge does not exist, but because it is rarely or wrongly applied. Economic and environmental considerations and aspirations should be harmonized. It is true that we live in the age of advanced technology

and explosion of knowledge and achievements, but this is primarily - the age of ecological ethics. Transformation of the science and practice, which we belong to, started a long time ago.

Planning and implementation of forest management can and should be environmentally sustainable, economically feasible and profitable, socially responsible and politically acceptable. Due to the increased pressure and demands that the most valuable forest ecosystems are faced with (such as negative claims on forestry and state ownership, change of purpose of forests and forest land), especially the protected natural areas and resources, it is necessary to prevent implementation of decisions that have harmful effects on biodiversity, natural resources and environment. Forestry experts should be engaged in decision-making concerning space utilization (development of spatial plans, zoning plans, etc.). All forest engineers need to expand their knowledge, especially on environment, information and communication, information technology, etc. We also need to improve cooperation between sectors, institutions and professions, in order to ensure a participatory approach in practice. It is also necessary to improve data management and upgrade information infrastructure concerning assessments and monitoring of the global forest biodiversity state. Finally, it is necessary to continue to develop strategies, action plans and other forms of passive and active measures of biodiversity protection at the global, regional and national levels.

Modern forestry, based on the principles of integrated or multiple user forest management, with strong ecological and social aspects is not only a reaction to mono-functional and industrial forestry, but also to the current relationship of man and society to the nature in forests. We live in the age which can prove that "water has memory ' challenge the theory of `*Big Bang*` and the Darwinian concept of evolution, revive anthroposophical principles and principles of permaculture and of green living movements. We live in the age which is rightly called the age of spirituality and ecology. Therefore, modern forestry is the science with good prospect, unavoidable in scientific aspirations to understand the complexity of these ecosystems and all phenomena, processes and laws that relate to the forest and its ties with the man.

"SEVEN BILLION DREAMS. ONE PLANET. CONSUME WITH CARE!"

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