# SERBIA

*Sasa Stamatovic*

## Introduction

This report was produced under the technical supervision of the Environment, Climate Change and Bioenergy Division (NRC) as output from an FAO-supported project. The Republic of Serbia became a Party to the UNFCCC in 2001, as a successor to the Federal Republic of Yugoslavia, which had acceded to UNFCCC in 1997. Serbia has ratified the Kyoto Protocol as a non-Annex I Party, and it came into force in the Republic of Serbia on 17 January 2008.

After the Convention was ratified and came into force, serious efforts have been made to establish appropriate policy, institutional and legal frameworks to meet Convention commitments. However, these efforts have not resulted in substantial improvements, so Serbia is late in fulfilling its commitments under the Convention, including preparation of the Initial National Communication (INC). This is mainly due to complex political, economic and social conditions in the period of the 1990s and early 2000s, including breakdown of the former country and a series of Balkan wars, international isolation, deep economic crisis, and more recent challenges linked to reforming the state administration and implementing reforms for transition to a market economy.

With the support of the Italian Ministry for the Environment and Territory, and UNDP, the Serbian Designated National Authority (DNA) has been operational since November 2008 and it is hosted by the Climate Change Unit within the Ministry of Environment and Spatial Planning. The UNDP country office for Serbia, as an Implementing Agency of GEF, provides support to the Ministry of Environment and Spatial Planning of the Republic of Serbia in preparing the Initial National Communication.

South East European Climate Change Framework Action Plan for Adaptation (financially supported by the Royal Ministry of Foreign Affairs of Norway) has been adopted by the Ministers responsible for environment of the Republics of Albania, of Bosnia and Herzegovina, of the former Yugoslav Republic of Macedonia, of Montenegro and of the Republic of Serbia.

The Republic of Serbia accepted European and international legislation and standards as a benchmark for development of national legislation in the process of EU accession. Several sectoral strategies relevant to climate change either have been prepared or are in the process of preparation (including waste management, energy, regional economic development, forestry and transport). In addition, the process of implementation of the National Strategy for Sustainable Development is currently underway. Still, the current framework is not sufficient for the implementation of the Convention, reflecting the limitations in available technology, research, systematic monitoring, public awareness, education and training, information sharing and networking.

The forestry sector, as a part of Serbian society, went through same historical, social and economic events. In 2002, the Government of Serbia requested FAO to provide technical support for developing a modern and adequate policy and legislative framework for sustainable use of the forest resource base. In April 2003, a Technical Cooperation Project (TCP) funded by FAO was launched and hosted by the Directorate of Forests. This project, which was completed in March 2005, provided a basis for implementing a comprehensive three-year Forest Sector Development Programme, financed by the Government of Finland. The overall objective of this comprehensive project (GCP/FRY/003/FIN; www.forestryprojectserbia.org.rs), implemented during the period June 2005–May 2008, was to support the development of forest sector reforms and thus make a more significant contribution to the national economy and poverty reduction in rural areas. Scope of services included technical support by international and national forest experts, and studies in a

number of areas of particular importance for the future development of the sector. In addition to the GCP/FRY/003/FIN project, FAO is currently implementing a project on wood-based bio-energy use; and the Norwegian Government supported a two-year project on National Forest Inventory and Forest Certification.

## Summary of climate change dimension

### Review of information

In view of the complexity of climatic elements and their mutual interaction, some data indicate that the Serbian forest ecosystem could face additional stress.

### Air temperature

The annual air temperature in Serbia increased from the normalized value for air temperature in 1983, with rapid increase continuing from 1987 to date. The summer of 2008 was the 19th consecutive summer exceeding the historical average. Deviations from historical average air temperatures vary by region. Figure 1 shows the spatial distribution of temperature levels deviation from the 100-year average for time series 1951–2008 and 1991–2008. The figure shows that the average air temperature risen by >1°C over the 50 years on more than two-thirds of Serbian territory, with air temperatures rising by up to 2.2°C in some regions. Comparing those two time series, it could be concluded that temperatures have risen more rapidly in the last two decade than before. The increase was significant for northern Serbia and the Timocka Krajina region. Since the mid-1980s, occurrence of tropic days and more frequent occurrence of heat waves (several days >40°C) have also been observed.

**Figure 1. Annual air temperature trend (left – year; right – summer period)**

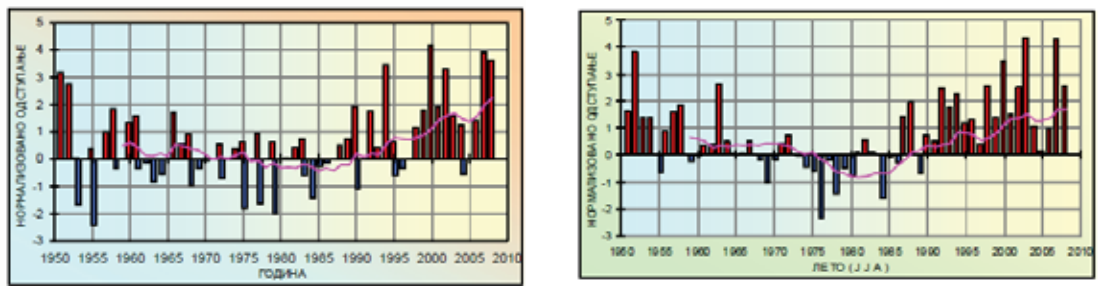
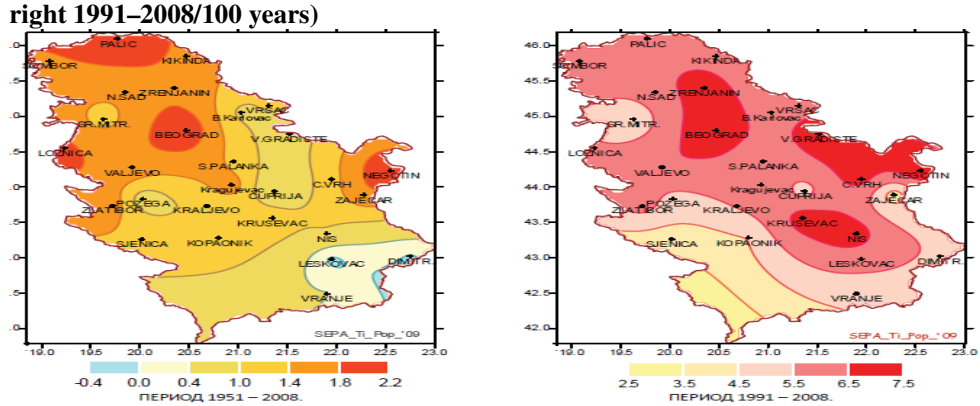



**Figure 2. Territorial distribution of annual temperature trend (left: 1951–2008/100 years; right 1991–2008/100 years)**



## Precipitation

An analysis of the annual and seasonal precipitation in relation to the historical normal values has shown mostly negative trends, except in the autumn, when it was positive at most stations in Serbia. Figure 4 shows that the precipitation trend in the last two decades has become rapidly negative, particularly in eastern and southeastern regions.

**Figure 3. Precipitation deviation (left: annual; right: summer period).**

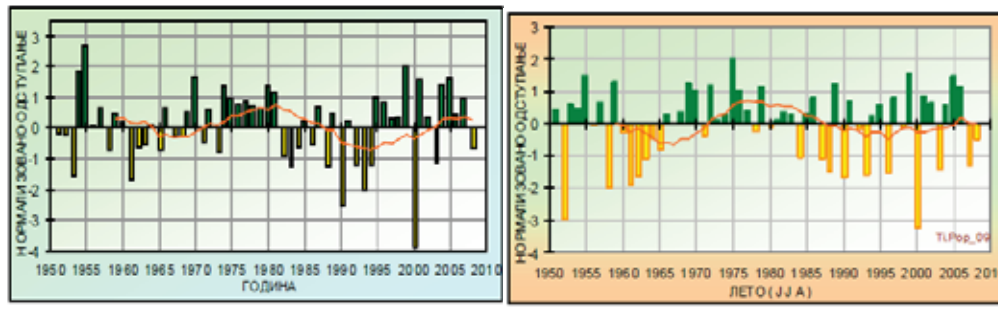
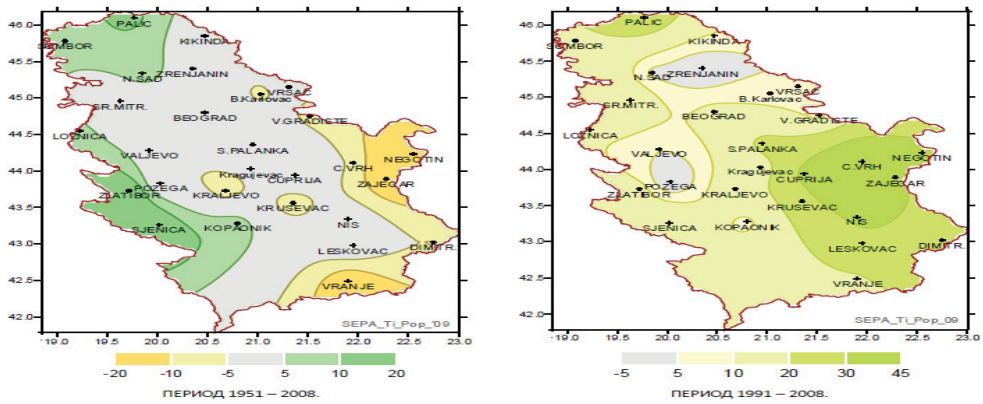



**Figure 4. Territorial precipitation trend as percentage of long-term average (left: 1951–2008; right: 1991–2008)**



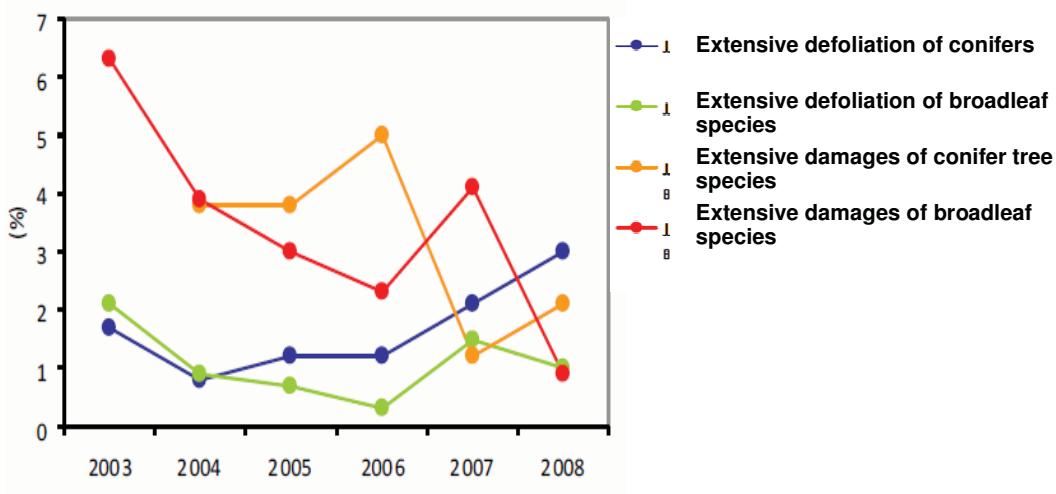

## Climate extremes

The Hotspots Project initiated by the World Bank has identified southeastern Europe as a major natural disaster hazard for hotspots, exposed to floods, droughts, forest fires, wind storms, heat waves, earthquakes and landslides. Regarding the South East European Climate Change Framework Action Plan for Adaptation, Serbia suffered from floods in 1999, 2000, 2002, 2005 and 2006, with major droughts recorded in 1989–1991, 1993, 2000 and 2007.

## Climate change and Serbian forests

Forests are climate-sensitive systems and have been strongly influenced by increasing temperatures and reduced precipitation during the summer period, boosting the risk of forest fires. In summer, high temperatures, low air humidity and dry fuel represent favourable conditions for forest fires. The changing climatic conditions could thus affect the frequency and magnitude of forest fires. In addition, extreme climate events, such as spring temperature events and summer drought, are expected to increase in frequency and duration. The effect of these could be to render the trees more sensitive to other challenges, such as new pests and diseases. Insect and fungal attacks could also be aggravated by climate change.

**Figure 5. Cumulative defoliation (weak, moderate and extensive)**




Starting from 2003, the National Focal Centre – Institute for Forestry, Belgrade, in collaboration with the Faculty of Forestry, Belgrade, and the Institute for Lowland Forestry and Environment, Novi Sad, carried out a Serbian forest condition monitoring survey at Level I, under the framework of the International Cooperative Programme on Forest Condition in Europe (ICP Forest). Annual Reports were published (hard copy) for 2003 to 2009. Unfortunately, data collected from ICP monitoring 2003–2009 have so far not been analysed as a time-series bundle. However, it is important to note this as a potential source for further climate change effects consideration.

**Figure 6. Damage caused by forest fires.**

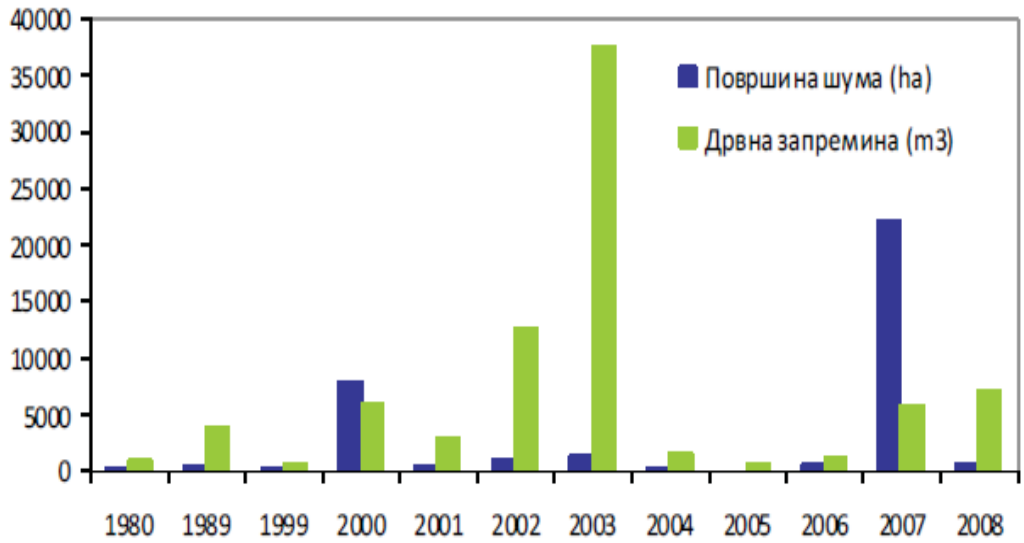
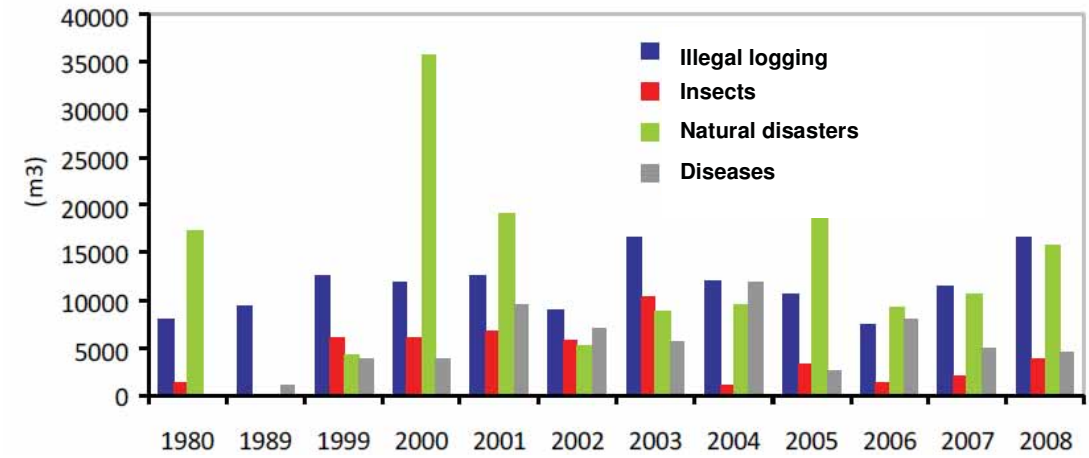


**Figure 7. Damage to forests caused by insects, natural disasters and illegal logging**




## Status of assessment and research on climate change

Climate change issues in general as well as in the forestry sector have gained higher profile in Serbia recently. So far, there is at least one climate change national publication related to forests: Forests and Climate Change Proceedings, 2007. These proceeding have been published by the Forestry Faculty and financed in part by the Ministry of Science and in part by the Ministry of Agriculture, Forestry and Water Management, Directorate for Forests. The publication exists only in hard copy in Serbian (with English summaries). The summaries of the papers mentioned from the proceeding have been incorporated here as Annex 1 to this country report.

### Proceedings content

- Forest as a factor for climate change mitigation. By Ratko Kadovic and Milan Medarevic.
- The role of forests in the realization of goals of UNFCCC. By Danica Spasova.
- Methods of assessment the regional impacts of global climate change – European context. By Milan Dacic.
- The tendency of air temperature changes and precipitation quantity in the region of the Republic of Serbia. By Tihomir Popovic.
- Sustainable forest management – forest biodiversity and climate change. By Milan Medarevic, Stanisa Bankovic, Biljana Sljukic and Anita Svilacic.
- Climate changes and their potential effects on causes of diseases of forest trees and shrubs. By Dragan Karadzic.
- The influence of climate change on harmful forest insects. By Ljubodrag Mihajlovic.
- Carbon reserves and dynamics in forest ecosystems in Serbia. By Ratko Kadovic, Milan Medarevic, Milan Knezevic, Vojislav Bajic, Branako Glavonjic, Snezana Belanovic and Nenad Petrovic.
- Afforestation and reforestation as a potential for climate change mitigation –European context and programmes in Serbia. By Milan Medarevic and Ratko Kadovic.

These papers present general considerations about climate change and forests and they do not necessarily reflect Serbian conditions. Hence, as noted in the preface of the publication, the publication should be understood only as an incentive for further scientific and expert discussion, and information for decision-makers. Complex political, economic and social conditions from the 1990s mean that Serbian forest researchers have postponed reaction on climate change issues. Subsequently, some actions have been initiated recently.

## Main characteristics of current research projects

**Change in forest ecosystems as an impact of global warming.**
*Developer*: Institute for Forestry, Belgrade.
*Duration*: 2008–2010 (36 months).
*Financed by*: Ministry of Science.
*Brief project description*: Field sampling and collection of relevant data, laboratory and statistical analyses to attain the project expected outputs.
**Expected outputs**

- Model developed of tree and tree stands development of the main tree species in Serbia in the light of global warming.
- Dendroclimatic research.
- Impact of climate change on morphogenetic potential of relict, endemic, rare and threatened species in natural populations.
- Impact of climate change on phenophase flushing and quality of reproductive material.
- Appropriate selection of seed material.
- Defining key climatic factors for insect problems (particularly gypsy moth, Limantria dispar) and modelling influences.
- Defining the most important climatic factors for tree diseases.
- Changes in vegetation zones caused by global warming.
- Proposed measures for reducing negative influence of global warming on forest ecosystems.

**Analyses of forest ecosystem sensitivity to climate change in the Republic of Serbia**
*Developer*: Institute of Lowland Forestry and Environment, Novi Sad.
*Duration*: 24 months (start date: July 2009)
*Financed by*: Ministry of Agriculture, Forestry and Water Management, Directorate for Forests.
*Brief project description*: The project is developing through a number of activities:

- Selection of characteristic forest stands.
- Field sampling of stand condition.
- Installation of equipment for microclimatic parameter monitoring.
- Field measuring of various relevant data.
- Analyses of collected data.
- Promotion of results.

**Expected outputs**: Project reports on results achieved, with recommendations for a climate change strategy and measures for improving the sustainability of Serbian forests.

**Forest Policy – Climate change adaptation context**
The South East European Climate Change Framework Action Plan for Adaptation has influenced the Serbian National Climate Change Policy Framework, which includes a large number of strategies, laws and other legislation, such as: The Law on the Ratification of the UNFCCC; the Law on the Ratification of the Kyoto Protocol; the Law on the Ratification of The Convention of the World Meteorological Organization; the Law on the Ratification of the UN Convention on Biological Diversity; the Law on Environmental Protection; The Law on the Ministries; The Law on Hydrometeorological Activities; the Law on Waters; the Law on Meteorology; the Strategy for Sustainable Development; the Forest Development Strategy of the Republic of Serbia; the Energy Development Strategy of the Republic of Serbia to 2015; and the Millennium Development Goals in Serbia, 2003.

Some of the national priorities in the development of climate change policies include a continuing process of harmonization of national legislation with the EU regulations; adoption of the National Strategy for the incorporation of the Republic of Serbia into the CDM under the Kyoto Protocol, as

well as the Framework Climate Change Strategy and Action Plan; capacity building for all stakeholders involved in the development and implementation of climate change policies, including fields of science, research and development; campaigns to raise public awareness with regard to climate change issues; support to multidisciplinary and inter-sectoral projects for the assessment of effects, vulnerability and adaptation options; and improvement of inter-sectoral communication.

The Forest Policy document—Forestry Development Strategy of the Republic of Serbia—was adopted by Government in July 2006 as a framework national forest policy document. Forestry Development Strategy is a contemporary and comprehensive strategic document based on principles of sustainability and multifunctionality, protection and conservation (of forests and rural areas), participation of stakeholders, public information, and others, but in terms of implementation feasibility aspects, the document is very general. The strategy has set the general development goals for the forest sector and defines the measures for achieving those goals.

**Corresponding goals and measures referring to climate change**
The chapter on guiding principles for the forest sector says:

- Forests have an irreplaceable role in the mitigation of climate change caused by anthropogenic impacts and, in this sense, carbon sequestration. Efforts should be made to increase permanently forestal capacity in this respect.
- The strategy and legislation in forestry will be based on national interests and shall be harmonized with international commitments.
- The conservation of forest health and viability will be defined as an obligation and responsibility at local, regional and global levels.
- The permanent building of national capacity in education, science and research, technology, economy and social aspects of forests and forest management is essential for forest conservation and sustainable development.

**Main objective and measures addressing climate change adaptation**
The overall objective is to increase the contribution of the forest sector to the economic and social development of the Republic of Serbia, by establishing an efficient system of forest protection against harmful biotic and abiotic factors, illegal felling, illegal occupation, illegal building and other unlawful actions, and also a system for monitoring forest health condition and viability pursuant to UN/ECE and EU methodology.

Objective 1 is the conservation, advancement, sustainable utilization and evaluation of protective, social, cultural and regulatory forest functions.

- The Government will, bearing in mind the forest hazard caused by anthropogenically induced climate change and their regulatory functions in the global carbon cycling, support research into and analysis of the potential scope and method of carbon sinks in forests, promote the efficient generation and consumption of bio-energy from sustainably managed forests, pursuant to UNFCCC and the Kyoto Protocol, and thus create the conditions for applying for international funds for increasing the forested area.

Objective 2 is the education of the competent professional staff for the forest sector.

- Development of a forestry education strategy as the basis for a modern education system consistent with the needs of forestry development in the changed socio-economic, scientific and technical conditions.
- Education and innovation of knowledge through permanent training of those employed in the State Institutions and public services of the forest sector.

Objective 3 is the fostering of applied multidisciplinary research, development of forestry technologies and capacity building in research institutions.

- Institutional strengthening and building of existing research capacities in forestry, wood industry and nature protection.
- Implementation of the national plan and strategy of forestry research with the participation and financial support of the Government and end users.
- Strengthening and coordination of international cooperation in research and capacity building in forestry and wood-based industry.
- Support for participation of national researchers in international project teams of foreign research and education institutions.

Objective 4 is to establish and maintain mechanisms for efficient collection, storage, analysis and exchange of information within the forest sector and among other sectors, and awareness raising amongst the general public on the importance of forests and forestry for society in general, with the active participation of all stakeholders.

- Institutional and technical pre-conditions for the establishment of the information exchange system and efficient cross-sectoral and inter-sectoral communication in the country and at the international level, and, in this respect, the constitution of a Forest Council.
- Information on the status of resources, measures and activities implemented in forest improvement, protection and utilization, and especially in the implementation of the future National Forest Programme should be available to all stakeholders and to the public.

Objective 5 is to establish and strengthen international cooperation at the global and regional levels in all aspects of forestry and related fields, based on equality and national interests.

- Conditions established for the implementation of the international resolutions, conventions and treaties ratified in the field of forestry and nature conservation.
- Regular participation in international conferences aiming at active participation in the processes and the preparation of significant documents for the development of the forest sector.
- Promotion of regional cooperation in forestry, aiming at sustainable utilization, management and conservation of forest ecosystems.

Climate change issues, particularly the adaptation aspect, are not completely incorporated in the Strategy in a comprehensive and sufficient manner, although it does not create any obstacles for further development and implementation of those issues in action plans.

The Forestry Development Strategy of the Republic of Serbia defined a Forest Development Programme (Action Plan) as a tool for strategy implementation. A draft Action Plan was prepared in 2008 by the FAO GCP/FRY/003/FIN Project “Forestry sector development in Serbia”. This project is currently being extended in order to upgrade and finalize the Action Plan.

The latest version of the Action Plan proposes various activities and measures referring directly or indirectly to mitigation and adaptation actions. The plan is that the Action Plan will be implemented from 2011 to 2020. The main goals in the Action Plan relevant for climate change adaptation are:

- A significant increase in annual forestation rate and proper silvicultural care of young forests (from about 2500 ha/year to 5000 ha/year).
- Significant increases in all silvicultural measures in order to improve forest structure and condition (pre-commercial thinning, conversion of coppice forest, reclamation of damaged forest, etc.).
- Specific measures for improvement of the forest protection system include improvement of forest protection services; improvement of ICP monitoring system; and improvement of diagnostic and prognostic services.
- Improvement of forest reproductive material production in both quality and quantity.

- Increased activities on construction and maintenance of forest roads.
- Establishment and maintenance of an efficient national forest information system.
- Improvements in forestry research and education systems.
- Improvement of the capacities of the public forest administration.
- Development and implementation of a plan for international cooperation.
- Development and implementation of a plan for cross-sectoral cooperation.

A list of priority research themes is being developed, and in addition to numerous cross-sectoral issues with respect of climate change there is specific "Study on adaptation of Serbian forest and forestry".

A third major element on Serbian forest policy is the Law on Forest. It was expected that a new law would be adopted by the Serbian Parliament in the near future. Among other provisions, it should provide proper support for implementation of the Strategy and Action Plan.

Recognizing the inefficiency of the present monitoring system, the law defines roles and responsibilities for permanent monitoring and diagnostic and forecasting service, together with a national forest information system. Various activities are marked as "activities of public importance" and will be financed from the State budget.

Establishment of a new financial instrument in the form of a so-called tax for environmental services will be crucial for the future of the national forestry programme as a whole. After the expected adoption of the Forest Law and Action Plan, it seems that a proper and contemporary National Forest Policy framework will be achieved. However, that does not mean that the job is done, but it should provided incentives for intensification, further development and implementation of the designated goals, objectives, activities and measures with respect to climatic change.

## Areas proposed for cooperation

Further development and implementation of adaptation issues could be have two foci: assessing the impact on forests and forestry; and adaptation measures. For addressing climate change effects, some further actions should be prioritized:

- Intensification of research on the impact of climate change (plant health, extreme events, forest fire, pests and diseases) on vulnerability of various forest ecosystems, age classes and regions, including risk mapping.
- Impact on forest biodiversity.
- Forecasting of future impact.
- Research into socio-economic implications, including impacts on wood and NWFP markets, losses from forest disasters, loss of forest productivity, impact on rural populations, and non-market goods.
- Upgrade monitoring (ICP level 2) and warning systems to survey fires, insects, diseases and other disturbances in forestry.
- Incorporating forest damages statistic and ICP monitoring database in a national forest information system.
- Improvement of international cooperation, particularly for exchange of information and knowledge.
- Public awareness and information campaigns.
- Studies that explore options to reduce both short- and long-term vulnerability of forests.
- Development of Good Practice Guidelines for silvicultural measures, particularly on afforestation, including recommendations on tree species and planting technology for various field conditions.

- Research on genetics and nursery production devoted to production of resistant planting material.
- Prioritized forest road construction and maintenance in high-risk regions in order to improve fire management systems.
- Improved equipment for forest fire services.
- Improved cooperation with other relevant sectors and institutions, such as the meteorological service, rural development, national fire service, and agriculture.

Some financial, technical and capacity gaps and constraints could present obstacles for above proposed actions. FAO and other UN agencies could serve to facilitate meaningful participation and contribute through support to research and systematic monitoring, dissemination of available technology, public awareness, education and training, information sharing and networking.

The Belgrade Institute for Forestry organized an International Scientific Conference on "Forest ecosystems and climate change" in Belgrade, 9–10 March 2010. One of the conference topics was to present progress of the ongoing project "Change in Forest Ecosystems as an Impact of Global Warming". The presentations from the conference were to be used as sources for a planned international workshop on "Climate Change Impacts on Forest Management in Eastern Europe and Central Asia".

There is a clear willingness among national research institutions for collaboration with FAO and UNDP. Stress was placed on FAO's participation in process and advocacy in the Serbian forestry sector, particularly in view of the growing recognition of forest's important role in climate change issues.

## References and other sources used

Report on state of environment in the Republic of Serbia 2008 -Serbian version (Izvestaj o stanju zivotne sredine u RS 2008) Agency for Environmental Protection www.sepa.sr.gov.yu based on source of Data The Republic Hydro-meteorological Service of Serbia (RHMSS)

South East European Climate Change Framework Action Plan for Adaptation based on Synthesis Report on South Eastern Europe Countries Disaster Risk; RMSI; 2007 and EM-DAT: www.em-dat.net and SEEDRMI/Desk Study Review Risk Assessment, in South-Eastern Europe – Final Report (ISDR,WB,2007)

### Annex 1. English summaries of papers from the publication *Forests and Climate Change Proceedings, 2007*.

**Forests and climate change**
*Kadović, R., Medarević, M., Editors*

Based on the current discussions on climate change and its effects on various societal fields, most scientists in the world have accepted the fact that human activities, first of all the burning of fossil fuels as well as the systems of land use, have influenced climate change. Climate is changing and it is going to change as a result of rising concentrations of gases with a greenhouse effect in the atmosphere. However, the speed and consequences of such a change during the 21st century are very uncertain, especially in the regional sense, although they will probably be serious. According to different scenarios and reports, climate changes will essentially influence the changes in natural systems and some key resources of the environment (agriculture, water resources, forests, coastal regions) and thus the economy sector as well.

Consequently, there is great interest of obtaining and collating the best information on importance and speed of future climate change and effects of the changes on environmental systems, among other things. Without reliable information as the basis for further activities and decision-making, we may face the risk which is unfavourable for natural resources and, in every way, for further generations.

Forest ecosystems are natural systems that are considered sensitive to unfavourable effects of climate change in almost all parts of the world. During the 1970s, discussions began on forestal effects in reducing global climate changes. Later, the importance of forest potentials has been accepted in numerous international discussions and analyses, as well as interest in defining and quantifying its role in climate change and establishing systems of mechanisms in international cooperation. Consequently, forest management will have an important role in the process of 21st century global warming. Within the advisory organ of the Science and Technology Convention 2005, a five-year programme on adapting and intensifying national activities in this field was adopted. Signatory countries are obliged to carry out a detailed analysis of climate change effects on forest ecosystems and to suggest adaptation measures. The countries send their national reports to the organs of the Convention.

Taking into consideration the complex role of forests and the sector of forestry in the realization of the goals of the UNFCCC and its Kyoto Protocol, the advancement and national use of forest ecosystems for the Republic of Serbia has strategic significance. Based on strategic priorities and forest policy, it is necessary to develop a sectoral strategy for joining the Clean Development Mechanism as an integral part of the National Strategy for CDM, then to provide conditions for carrying out the programme of systematic monitoring and researching the effects of climate changes on forest ecosystems as the basis for making a strategy and action plan of adaptation measures in forestry.

In early 2003, a project “Protection and Sustainable Development of Forest Ecosystems of Serbia” appeared, and with a subproject `Climate Change and Sustainable Development of Serbian Forest Ecosystems` at the Ministry of Natural Resources and Environmental Protection of Republic of Serbia, but its realization was interrupted in the beginning of 2005. Since 2006, within the scientific projects of Ministry of Agriculture, Forestry and Water Management –Directorate of Forests, the research has partially recommenced. In view of all this, the authors of this publication hope that, beginning with the issues of interaction between forest and climate change as a stimulus, they will stimulate a scientific and expert discussion on the one hand, and stimulate decision-makers on the other hand to develop and apply the strategic activity plan in the forestry sector.

**Forests as a factor for climate change mitigation**
*Kadović R., Medarević, M.*

Human activities are almost exclusively responsible for the disturbance in the carbon dioxide global circulation, mainly caused by fossil fuel burning, which increases the level of carbon dioxide in the atmosphere, and by destroying the forests that act as absorbents of carbon dioxide. Approximately 7.6 million tonne of carbon are emitted into the atmosphere each year, from which 6.0 million tonne originate from fossil fuels, and 1.6 million tonne from deforestation (IPCC, 1992). As an important reservoir of carbon, forests are considered to have a significant potential for global warming mitigation through their capacity for carbon sequestration and accumulation. However, the management potential, measures of mitigation and forest adaptation to future global conditions of environmental changes vary very much from one state to another.

In projecting options of saving and carbon sequestration in forests, the influences of land use systems that are of critical importance for future carbon emissions, e.g. reducing forested areas and expanding agriculture, should be taken into consideration. The forests and systems of land use have the potential for reducing carbon emission equivalent to 10–20% of the projected fossil fuels emission by 2050.

As the forests are getting more important as the means for carbon sequestration, the future systems of forest management are likely to be estimated on the basis of their effectiveness in the realization of this function, which will result in *Pro-C* silvicultural methods (for carbon sequestration from the atmosphere). These systems can be classified into four categories:

- slowing deforestation and forest degradation,
- expansion of the existing carbon sinks through forest management,
- creation of new carbon sinks through expansion of forested areas, and
- substitution of fossil fuels by renewable, wood-based fuels.

Adoption of such long-term policy will have the added benefit of enhancing other environmental objectives, such as protection of biological, water and soil resources.

**The role of forests in the realization of goals of UNFCCC and its Kyoto Protocol**
*Danica Spasov*

Taking into account the importance of forest ecosystems in the process of elimination of GHG effects from the atmosphere, the issues of forest protection and advancement and the participation of forestry in mitigation of climate changes have been regulated through the general obligations of all state members of these international agreements. The issues on LULUCF have been and still are very interesting within the multilateral negotiating process taking place within the international agreements. As a result of these international negotiations, a number of obligatory decisions and methodologies related to including forestry into the strategies of adaptation and mitigation of climate change, i.e. the measures for reducing anthropological emissions of GHG effects, have been adopted. The importance of the forestry sector in solving climate change problems is best illustrated by the EU strategic approach of estimating the forest's role and the involvement of the forestry sector in Kyoto Protocol implementation, in addition to establishing priority technical measures with optimal potential for carbon sequestration.

Furthermore, some regulations of the Convention and Kyoto Protocol determine the possibility of participation of developing countries, including our country as well, in the Clean Development Mechanism, as one of the three flexible mechanisms of GHG trade emissions, through afforestation and reforestation and appropriate activities in forest management.

Regarding the strategic interests of the Republic of Serbia in forestry and varied roles of forests in realization of the goals of UNFCCC and its Kyoto Protocol, a detailed review of the Convention and Kyoto Protocol regulations, has been implemented, as obligatory decisions relating to forest ecosystems and the forestry sector. The most important measures of EU in forestry have also been analysed, as well as the conditions of including our country in the CDM through afforestation and reforestation projects.

**Methods of assessment the regional impacts of global climate change-European context**
*Dacić, M.*

The growing need of the scientific and expert public, decision-makers in Government as well as the broader public, for realistic assessments of possible regional reactions to global climate change, has emphasized the importance of regional climate simulations. The problem of regional climate change projection can be identified as the problem of presenting the effects of atmospheric forces on different space scales: forces on a large scales that modify the global atmospheric circulation and cause the sequence of weather situations characteristic of climate status in a particular region (e.g. the high levels of GHGs in the atmosphere); and forces on a medium scale (e.g. complex mountain systems) that modify local circulations and thus regulate regional division of climate changes. The patterns of general atmospheric circulation present the

main means of climate simulation. Unfortunately, the resolution of these patterns is too inexact to describe atmospheric forces on a medium-scale and thus adequately simulate regional climate details. This text describes the current approaches to solving problems of defining regional effects of global climate changes that the patterns of general atmospheric circulation indicate. Apart from a review of the existing methods, a preliminary result of the regional climate simulation of the European continent has also been presented here.

**Trends in air temperature changes and precipitation quantity in the region of the Republic of Serbia**
*Popović, T.*

According to numerous analyses and estimates, global warming will probably bring a great number of changes. Depending on economic potentials, the possibilities for adaptation to many of these changes varied. However, adaptation is often expensive and is not always successful or feasible. That is why climate change presents an additional, serious stress for our national resources and valuable regions that are already on danger. The main purpose of this work is, therefore, to point out the possible conditions that our forest ecosystems will face during global warming, and the kind of actions we can take, based on research into air temperature change trends and precipitation in the Serbian region. Analyses carried out using a moving trend for annual air temperature in Serbia show that there have been periods with a dominant negative and periods with a dominant positive trend. The period of negative trend domination of the annual air temperature in Serbia began in 1951, and ended in 1952. Since 1983, and especially 1987, some positive trends at first of shorter, and later longer, series have been detected. According to data from 1951–2005, the trend has been maintained. In fact, it means that the average annual air temperature in Serbia has been rising since 1983 and the process continues.

According to some data from the period of 1951–2005, territorial division of summer air temperature trends shows that average summer air temperature has been rising by more than 1°C for 100 years on more than two-thirds of Serbian territory. The fastest increase in summer temperature, up by 2.5°C in 100 years is in the regions of the north and west of Serbia, the territory of Belgrade and Timočka Krajina. A slightly negative tendency of summer air temperature is in the southeast of Serbia, in the region of Leskovac to Dimitrovgrad.

The analyses obtained by using a sliding tendency show that the annual amount of precipitation in Serbia has been declining for the last 55 years, by about 5% of the historical normal of the last 50 years. With the reducing length of the given series, the mark and intensity of the tendency are changed. For series less than the last 25 years, positive tendency values in the annual amount of precipitation have appeared. The beginning of the period of rising air temperature in Serbia has been followed by a period of reduction in annual precipitation.

**Sustainable forest management – forest biodiversity and climate changes**
*Medarevic, M., Banković, S., Šljukić, B., Sviličić, A.*

Sustainable management implies the management and use of forests and forest lands in such a way and scope (degree) to preserve biodiversity. European criteria and indicators that are used to control the relationship towards this goal of sustainability, applied to the forests of Serbia, indicate the following:

- The total surface of forests in Serbia is 2 144 498 ha while the surface of underbrush and shrub (and the rest of the forest land) is 175 222 ha.
- Sixty-eight tree species, of which 15 are introduced, have been recorded within forest reserves. Of these, it is possible to easily manage 10 of them commercially, while 38 species are in the list of rare and endangered (17), relic (9), endemic (6) and at a risk (6) species.

- As for regeneration of forests, it can be concluded that there have been some changes and an expansion of forested areas.
- Regarding natural indicators, virgin types cover 0.2% of the total surface, modified natural forests 92.7%, semi-natural 5.4% and production plantations 1.7%.
- Introduced tree species cover 1.7% of the total forest area.
- The estimated biomass of dead trees is 10–16%, which is a favourable value.

In order to provide forest reproduction and the protection of the genetic stock of the basic species, 1017 ha of seed reserves have been identified. Forest and other ecosystems are characterized by regional variety, which is mainly caused by bio-ecological variation. There are 534 232 ha of properties in Serbia with various types of natural protection (6.5%) within 1302 protected properties. In order to mitigate the negative effects of climate change on forest biodiversity, the main activities on a global scale are to:

- Advance monitoring and researching on climate change effects on forest biodiversity and atmosphere.
- Develop strategy and action plans on global, regional and national levels as a coordinated agreement.
- Advance the protection and regeneration of forest biodiversities in order to increase their capacity to resist, adapt to and recover from climate change.
- Advance the protection and regeneration of forest biodiversity in changed climatic conditions, by mitigation and adaptation activities.
- Estimate how which the protection and sustainable use of forest biological diversity can contribute to international efforts regarding climate change.

**Climate change and the potential effects on causes of diseases of forest trees and shrubs**
*Karadzić, D.*

Climate changes have a strong influence on the state of health and survival of forests. There are some predictions in the world that the temperature will globally rise 1°C by the end of 2025, and by 3°C by the end of the 21st century. Land moisture is reducing due to warming, which affects the surrounding vegetation. Among forest tree species, the first to be affected are coniferous species with flat plate roots, e.g. spruce. The harmful effect is less visible with the younger stems, but with the middle-aged stems (that need more water) there is a growing physiological weakness and mortality. Dying is certainly not caused only by drought, but it makes favourable conditions for the appearance of parasitic organisms. For example, in poor spruce stands or mixed stands of spruce and fir, due to drought the physiologically weakened stems are being attacked by the fungus *Heterobasidion annosum,* which cause stem dieback.

Climate change effects on forests have been manifested both through direct and indirect influences. Critical moments for vegetation occur due to disharmony of the influence of climate parameters and phenophase appearance, characteristic of a specific region. Climate change is reflected in the rising average annual temperatures in some seasons, and in the reduction of precipitation during summer months. Coinciding drought periods, high temperatures and the influence of atmospheric pollutants in forest areas causes a reduction in stem vitality and, consequently, optimal conditions for the development of many pathogenic organisms. Therefore, it can be expected that there will be more and more diseases caused by harmful biotic factors each year, and the extent of damage to forest tree species will also increase.

There are still some disagreements in the literature on the influence of changes in the chemical composition of the atmosphere on global climate change, which is primarily shown in temperatures rising (global warming) and changed rainfall patterns.

The increased concentrations of carbon dioxide ($CO_2$), ozone and ultraviolet-*B* (*UV-B*) radiation may directly affect both the host plant and the pathogen. The plants grow more quickly under the influence of elevated $CO_2$ as the intensity of photosynthesis increases. The increased contents of fresh assimilations are likely to promote plant diseases such as rusts and powdery mildews (obligate parasites). Attacks by saprophytic insects will be greater, and they appear primarily as the vectors of viruses. The increased growth accumulates more biomass in the specific stands, which considerably affects microclimate change and the epidemic spread of these diseases. During autumn, large amounts of fallen leaves and other plant trash will be colonized by saprophytic and necrotrophic pathogens or bacteria, so that in the following spring the level of inoculum for new disease outbreaks will be greatly increased. Generally speaking, elevated concentrations of carbon dioxide induce greater plant productivity, which will indirectly affect disease spread patterns.

Ozone and ultraviolet-*B* (*UV*-B) radiation have a strong influence on plants, but the influence on pathogens is much less strong. In contrast to pathogens, the plants are directly under the influence of these factors. The growth of plants is reduced by the influence of ultraviolet radiation. Reduced net photosynthesis and premature ripening and senescence could result in a decrease in diseases caused by biotrophs (=obligate parasites) and an increase in those caused by necrotrophs (infect and grow better on weakened host tissue). In general, enhanced UV-B reduces net photosynthesis and induces the production of flavonoids, accelerated ripening and reproduction, and increases leaf soluble proteins and decreases membrane lipids. They may affect auxin synthesis and thus reduce plant height. A smaller production of assimilates will also reduce the susceptibility of plants to obligate parasites, while premature ripening and plant age will stimulate the appearance and growth of weakness parasites.

**The influence of climate change on harmful forest insects**
*Mihajlović Lj.*

Global warming, especially changes in annual average air temperature, will probably influence some harmful insects to expand their range and damage area, and to become distinct forest pests. Those are the species whose area reaches the borders of Serbia and that would probably expand their area in some changed climate conditions. Furthermore, those are the species that exist in the regions of our country, but their damage area is to the south of Serbia. And finally, there are insects that already cause some harm in the country, but with changed climate conditions they could become even more harmful. Species that would probably expand their range as conditions change are: termites (*Calotermes flavicolis* F., *Reticulitermes lucifugus* Rossi and *Reticulitermes flavipes* (Koll.)), pine scale (*Marchalina hellenica* (Genn.)), powder post beetle (*Lyctus bruneus* (Steph.)) and pine processionary moth (*Thaumatopoea pytiocampa* Schiff.). Other species whose damage area could expand are grasshoppers (*Caliptamus italicus* (L.), *Locusta migratoria* L. and *Dociostaurus marocanus* (Thunb.)). And finally, the species that would be even more harmful in new conditions are: longhorn beetles (*Stromatium fulvum* Vill. and *Hylotrupes bajulus* L.) and browntail moth (*Euproctis chrysorrhoea* L.).

**Carbon reserves and dynamics in forest ecosystems in Serbia**
*Kadović, R., Medarević, M., Knežević, M., Bajić, V., Glavonjić, B., Belanović, S., Petrović, N.*

According to programme researches, in 2005, methods and techniques of calculating the carbon contents and reserves in some components of forest ecosystems of Serbia were chosen. The estimates of carbon reserves and dynamics in the forest of Serbia were made on the basis of different data sources (Statistical Almanac, Public Enterprises for Forest Management, publications with data from adopted forest management plans, etc.). The data analysis on total annual wood use was mainly based on the publication by Glavonjić *et al.* (2005). The estimates also took into consideration the ownership (state or private forest), the proportion of deciduous and conifer species in the forests of Serbia,

silvicultural form and the amount of felling and sorts of production. The estimates on fire gases emissions were made on the basis of Statistical Almanac data.

The reserves of terrestrial organic carbon in the forests of Serbia were estimated on the basis of Monitoring ICP Forest for Level I data (Reports for years 2003 and 2004) and according to EU methods (Soil Sampling Protocol, 2005) and IPCC XXI session LULUCF, 2003. Based on the monitoring results of ICP Forest for Level I, we suggested the use of a network for monitoring the contents and carbon reserves in some components of forest ecosystems of Serbia, as well as forming and storing data using GIS technology.

**Afforestation and reforestation as a potential for climate change mitigation – European context and programmes in Serbia**
*Medarevic, M., Kadovic, R.*

A universal measuring system for reduction of GHG emissions has been realized on the European level by means of the European programme of climate change (ECCP). Afforestation, reforestation and sustainable forest management are of great significance within these measures. The basic principles and recommendations of the EU afforestation policy refer to:

- General issues on the balance of forestation enlargement and the principle of sustainable forest management and respect of the containment principle when implementing pan-European criteria and indicators.
- Institutional issues and legislation regarding the advancement of the planning system; defining forest policy and strategy, especially in relation to environmental protection; innovation and harmonization of laws; integration of forest and enlargement advancement plans into all relevant current strategies; coordination of plans with those for sustainable management of protected areas.
- Environmental issues regarding the estimate of forest cover enlargement influence on environmental quality and the protection of stands and of autochthonous species.
- Afforestation and reforestation project issues within CDM compatible in content with the previous issues.

The plan of forest enlargement in Serbia is based on strategic aims of forest arrangement and use, referring to:

- advancement of the existing forest situation,
- enlargement of forest cover, and
- arrangement and enlargement of the forest cover around big city centres.

By 2015, afforestation could cover 100 000 ha, including 4000 ha of field-protective forest belts, 20000 ha of erosion control forests, 33 700 ha of poor and marginal land (in zones around hydroaccumulations, cross roads and sources of air pollution), 5000 ha of suburban forests and 3600 ha within barriers. The expected effects of afforestation would be:

- reduced greenhouse effects by sequestration of 600 000 t/year of carbon,
- 400 000 m3 of annual wood production (valued at € 10 million per year,
- reduced negative effects of area and water erosion and slides,
- reduced negative effects of polluting emission influence,
- increased agricultural production,
- a better quality of life in urban areas,
- more employment, and
- significant enhancement of the environment on the whole.