

Forests and Climate Change Working Paper 8

Forests and Climate Change in Eastern Europe and Central Asia

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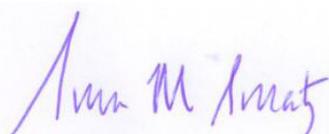
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Foreword

This document is part of the publication series of FAO's Forest and Climate Change Programme. The programme works to strengthen countries' capacities to mitigate and adapt to climate change through actions consistent with sustainable forest management and to promote regional cooperation and international policy development related to forests and climate change.

The primary objective of this document is to provide an overview of forest and climate change issues, actions and areas for cooperation in the Eastern European and Central Asian countries. The country reports included within were prepared and presented at the FAO workshop on "Climate change impacts on forest management in Eastern Europe and Central Asia", which was held in Sopron, Hungary from 14-16 April 2010. The workshop was co-sponsored by FAO's Sub-Regional Office for Central and Eastern Europe, the University of West Hungary (through the project TAMOP 4.2.2), and the Northern Eurasia Earth Science Partnership Initiative. It was also supported by the FAO Sub-Regional Office for Central Asia, the UN-ECE/FAO Timber Section, and FAO Headquarters. The workshop provided an opportunity to take stock of the situation in the region regarding forests and climate change and offered a venue for country representatives and others to exchange experiences, discuss areas of common interest and identify areas for potential collaboration. The proceedings of the workshop are available at: www.fao.org/regional/SEUR/events/sopron/sopron_en.htm

The countries covered in this publication are highly diverse ecologically and socio-economically, but share two distinct features that make them particularly vulnerable to climate change: the transition zone between closed forests and woodlands and forest steppe – a zone highly susceptible to drought - runs through these countries; and, with the exception of Turkey, these countries are in a phase of social and economic transition. Despite these facts, these countries are underrepresented in joint research programmes and international deliberations on climate change. It is hoped that the publication will raise awareness of the specific needs of these countries regarding forests and climate change, in particular regarding climate change adaptation but also mitigation, and will provide a point of departure for identifying and catalyzing regional action to complement and enhance national efforts. We hope that this publication will be of use to specialists and policy-makers in forestry and climate change in the Eastern European and Central Asian countries as well as forest managers, the academic community and the general public interested in learning more about forests and climate change in this region.



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Acronyms

A/R	Afforestation/Reforestation
CCCM	Canadian Climate Centre Model
CDM	Clean Development Mechanism
COP	Conference of the Parties
DNA	Designated National Authority
ERPA	Emission Reduction Purchase Agreement
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FNC	First National Communication
FPUA	Forest and Pasture User Association
GDF	General Directorate of Forest [Turkey]
GEF	Global Environment Facility
GHG	greenhouse gas
GFDL	Geophysics Fluid Dynamics Laboratory
GIS	geographical information system
GISS	Goddard Institute for Space Studies
ICP	International Co-operative Programme
INC	Initial National Communication
INTAS	International Association for the promotion of co-operation with scientists from the Newly Independent States of the former Soviet Union
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
IUFRO	International Union of Forestry Research Organizations
KazNIIK	Kazakh Ecology and Climate Research Institute
LULUCF	Land Use, Land Use Change and Forestry
MAFRD	Ministry of Agriculture Forestry and Rural Development [Kosovo]
MDGs	Millennium Development Goals
MEP	Ministry of Environment Protection of the Republic of Kazakhstan
MOE	Ministry of Environment Protection and Natural Resources of Georgia
MoEF	Ministry of Environment and Forest [Turkey]
MoEFWA	Ministry of Environment, Forestry and Water Administration [Albania]
MRV	Measurable, Reportable and Verifiable
NAMA	Nationally Appropriate Mitigation Action
NAP	National Action Plan [Albania]
NCBCC	National Coordination Board on Climate Change [Turkey]
NCCSAP	Netherlands Climate Change Studies Assistance Programme
NES	National Energy Strategy [Albania]
NGO	non-governmental organization
NRDP	Natural Resources Development Project
OECD	Organisation for Economic Co-operation and Development
PDD	project design document
PIN	project idea note
REDD	Reducing Emissions from Deforestation and Forest Degradation
REU	Regional Office for Europe and Central Asia
SFM	Sustainable Forest Management
SNC	Second National Communication
TACIS	Technical Aid to the Commonwealth of Independent States
TNA	Technology Needs Assessment
UKMO	United Kingdom Meteorological Office
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
US CSP	US Country Studies Program
VCM	Voluntary Carbon Market
WG	Working Group
WMO	World Meteorological Organization

REGIONAL OVERVIEW

Key ecological, socio-economic and policy considerations

The Eastern Europe and Central Asia countries represented in this volume are very diverse. The area reaches from the coast of the Adriatic Sea to the snow-capped peaks of the Tien Shan Mountains, and displays a high bio-geographical, socio-economical and cultural diversity. Predicted climate change impacts are similarly varied, ranging from land use changes in the Balkans, to desertification in the lowlands of Central Asia and melting of glaciers in the alpine zone of the Caucasus.

A common feature of the region, however, is that the drought (xeric) limit of closed forests is present in nearly all of the countries and its appearance is foreseen as a result of projected climate change in the others. These areas tend towards semiarid conditions, and are ecologically very sensitive. At the xeric limit, the closed forest belt transitions to woodland or forest steppe vegetation. In Southeast Europe, the ecotone is a densely populated and agriculturally important zone that has been under human influence for millennia. This belt reaches from East-Central Europe across the plains of Southeast Europe (Romania, the Ukraine and South Russia) and of Northeast Kazakhstan far into Southern Siberia and North China (Manchuria). A narrower and fragmentary transition zone follows the southern and eastern mountainous rim of the Central Asian plain. Predicted increased frequency of droughts and sinking of groundwater levels may threaten the stability of forest ecosystems of this zone. These changes foreshadow problems, not only for the forests themselves, but also for the multitude of ecological services provided by forests to society.

Another critical feature of the countries in this region, with the exception of Turkey, is that they are in a phase of economic and social transition after deep political disturbances. The region is experiencing rapid social and economic restructuring, which has significant impacts on essentially all aspects of society as well as on land use and land cover. These changes have left their marks on forests and on the sustainability of forestry in general. They also influence these countries' current level of economic resilience and capacity to respond efficiently and effectively to the challenges of climate change.

Despite the unique set of conditions and needs in this region, these countries appear to be underrepresented in joint research programmes, in international deliberations on climate change and in regional initiatives. Mainstream research on climate change has relatively limited coverage of Eastern Europe and Central Asia. The European Commission's Green Paper on "Adaptation to climate change in Europe - options for EU action" (Anon. 2007) focuses to a large extent on the issues facing Western Europe, with relatively limited attention on those of Southeast Europe, such as the possible effects of increased droughts on the quality of human life and on ecosystem services. This is likely an indication of lower level of awareness of the specific problems faced by this part of the region.

Engagement in climate change policy processes at international level

The level of awareness of climatic threats in general and the readiness to take measures on the political level is high across the region. There is strong motivation in all countries to take appropriate measures. Most countries have ratified the United Nations Framework Convention on Climate Change (UNFCCC) and have taken steps to create the legal and administrative frameworks necessary to support climate change adaptation and mitigation action.

Two of the countries represented in this publication, Turkey and Ukraine, are "Annex 1" Parties to UNFCCC (i.e. industrialized countries or countries in economic transition), while the others are non-Annex 1 Parties. These two categories of Parties have a different set of commitments

under UNFCCC and the Kyoto Protocol, including as regards emissions reduction commitments, use of “flexible mechanisms” (e.g. the Clean Development Mechanism and Joint Implementation) under the Kyoto Protocol, and reporting requirements to UNFCCC and the Protocol. The non-Annex 1 countries have access to existing climate change funds as well as those pledged in the Copenhagen Accord and future funds designated for assistance to developing countries for climate change adaptation and mitigation actions.

Country responses to climate change

The country reports contained in this publication provide detailed accounts of the current status of national initiatives, legal and policy frameworks for developing climate change adaptation and mitigation measures in the forest sector. They include lists of related national publications, studies, and projects on climate change and on its potential impacts. The reports describe the work carried out by national research institutions on climate change and identify areas for potential FAO technical assistance and for collaboration with partner organizations.

The nature of threats to forest ecosystems and their ecological implications in this region differ considerably from those encountered elsewhere in Europe and Asia and in other parts of the world. This distinction has been largely overlooked in international negotiations, in scientific studies on forests and climate change, and by international assistance programmes. The reports highlight specific circumstances and needs of these countries.

It is notable that despite awareness of the potential impacts of climate change in general terms, the country reports in this publication contain little information about observed effects of climatic changes on forests. Although details on the extent of climate change experienced in the last century are mentioned, impacts of increasing aridity in the second half of the twentieth century on the vitality or stability of forest ecosystems are not discussed. Similarly, detailed references about changes in the status of forest health (i.e. incidence of insect pests and diseases) in connection with climatic extremes are limited. The absence of such references indicates either that forests have not yet been negatively affected, forest monitoring is not sufficient to detect the changes, or the priority accorded to analyzing impacts of climate change is low. Impacts of climate change (albeit compounded by other, non-climatic stresses) on forests are evident in other regions, so it is unlikely that this region is exempt. Whatever the case, intensified efforts to focus attention on assessing the extent and nature of climate-induced changes on forests in the region are warranted. Several countries do not have a detailed weather/climate database and the climatological background necessary to downscale large-scale predictions to finer, local scale. The development and use of regional climatic and impact models are preconditions for effective identification of climatic impacts and for planning adaptation measures in the forest sector.

A sound forest monitoring system is another prerequisite for an effective climate change response. In general, forest information bases are relatively well developed in the countries of this region, although recent economic difficulties have led to reduced support for inventories. The level of available data on the exact distribution, area, type, structure etc. of forests varies considerably by country. Most countries feel that further development of monitoring methods is required.

Dwindling water resources and growing economic activity cause serious constraints in water supply especially in Central Asian countries. Little information is available, however, on the effect of changes in groundwater level in forest ecosystems. None of the reports address the fact that although forests are important for the regulation of the hydrologic system and for delivery of clean water, at the same time they are heavy consumers of water. Especially in areas at the aridity (xeric) limit of forest zones, the question of allocation of available water among uses may (and most probably will) arise with declining rainfall and increasing temperatures. Forest strategies of countries at the xeric limit have to deal with this issue. Some of the reports mention the risk to forests of

increasing frequency of wildfires as a result of aridification; this too is an area that should be investigated and addressed in connection with climate change in all countries of the region.

All countries reported in detail on laws and regulations regarding forestry, on the development of national forest strategies, policy documents etc. Only some, however, make reference to climate change adaptation measures. The response strategy most commonly mentioned is to continue efforts to achieve sustainable management of forests (e.g. increase of forest area, nature-close silviculture, introduction of certification etc.). The identification of specific silvicultural measures to increase the resilience of forest ecosystems in the face of climate change is a possible theme for future collaboration or workshops. Thus, there is a need to adjust national forestry policies and legislation and develop strategies in line with international obligations, taking in account the potentially important role of forests in climate change adaptation as well as mitigation.

Although the countries have laws designed to support the sustainable management and use of forest resources, the reports refer to illegal harvesting, law enforcement problems and unsustainable forest and agricultural land use. These contribute to forest degradation in a number of countries. The underlying drivers of deforestation and forest degradation have to be resolved and legal framework strengthened if sustainability and, in turn, resilience is to be achieved in the region.

Some of the reports highlight the importance of forestry to rural socio-economic conditions in the countries, but analysis is limited with regard to the future status of forestry in rural societies under changed conditions. Further work is needed to understand the ecological, economic and social role of forests and forestry in the region in a changed environment and the related cross-sectoral dynamics.

Adaptation in many countries will also necessitate the adjustment of policies on nature conservation. The reports indicate a high commitment to protection of biodiversity in the region. Although the designation and maintenance of protected areas is a positive development, the reports do not indicate plans or current management measures that take into account the expected impacts of climate change and their consequences for protected ecosystems. The predicted impacts and necessary adaptation measures are expected to be similar in neighbouring countries; therefore the potential for cross-border collaboration is significant. Despite this, the reports indicate that very few bilateral and regional cooperation programmes on forests and climate change have been initiated in the region. Such interactions and cooperation may help to overcome shortages in financing, research facilities and human and institutional capacities in individual countries. Regional networks could be developed to facilitate the sharing of information and experiences on forests and climate change among countries in the region.

The way ahead

Any progress in adaptation to climate change requires well conceived strategies and plans, a sound legal framework and an effective system to monitor developments. National climate change strategies and national forest strategy documents are of particular importance, but in many countries in the region these documents do not contain specific references to adaptation actions in the forest sector. Initiatives to formulate management guidelines and concrete silvicultural measures ("best practice") for adapting to climate change are needed. Criteria and indicators of progress in adaptation will need to be specified.

Permanent and reliable monitoring of climatic impacts has to be improved, taking in account the specific threats to forest ecosystems at the xeric limits, to survey changes in site potential, forest fire frequency, insect and disease outbreaks and other disturbances in forest ecosystems (e.g. growth decline, diversity loss, soil carbon degradation etc.). Forest damage statistics and forest health monitoring data have to be incorporated in the national forest information system. The realistic assessment of future climatic risks needs locally available weather and climate data as

well as downscaled, regional climatic and impact models. This is essential for effectively formulating tasks of adaptation and mitigation.

It is crucial that countries have the capacities in the forestry sector to identify threats and implement appropriate measures. Some countries of the region have expertise in climate change vulnerability and impact assessments as well as with development of forest carbon projects. Still, in nearly all countries the organizations responsible for forest data collection (inventory), monitoring and supervision need strengthening. Similarly, many countries need assistance in new climate change-related tasks, such as carbon accounting, the preparation and practical implementation of adaptation projects and the distribution of benefits. There is a need to upgrade professional education and postgraduate training to meet the specific challenges of climate change. Research and development of technologies are needed to reduce the risks and increase resilience of forests in the region. Significant knowledge gaps exist in all countries, including on the effect of climate change and variability on ecological stability, productivity and vulnerability of forest ecosystems, the climate tolerance and adaptability of main tree species and the carbon dynamics in forest ecosystems. Methods of terrestrial and remote-sensing inventory and monitoring in order to identify effects, to specify measures and to forecast future impacts, need also development. The potential of supporting research through existing forest research networks has to be explored.

Adaptation to predicted changes means new, perhaps unconventional, approaches and new tasks, which cannot be accomplished without further raising the awareness of professionals (through training, pilot projects, publications). To win public and political support, active involvement of the media and of educational institutions is necessary.

A shortlist of priorities

The reports mention a number of needs related to forests and climate change adaptation as well as mitigation. These were discussed and synthesized during the workshop in Sopron into three main areas: policy, forest management, research and training. The main points of common interest were summarized as follows:

Policy:

- Updating of forest and environmental laws, development of administration and governance;
- Development of strategies and policies in forestry for climate change adaptation;
- Development of international collaboration and of exchange of experiences;

Forest management:

- Development of “good practice” for climate change adaptation in forestry;
- Development forest inventory methods for climate change adaptation;
- Improvement of field and satellite monitoring of impacts;
- Support in forest reconstruction, afforestation, shelterbelt planting etc.

Research, development and education:

- Research in forest vulnerability to climate change impacts;
- Development of carbon inventory, accounting and economics;
- Capacity building in research, e.g. in modeling techniques;
- Capacity building of professional staff in climate change adaptation (graduate and postgraduate);
- Improvement of methods to advance public awareness.

ALBANIA

Haki Kola & Enkeleda Pjetri

Background information

Albania is playing a leading part in international efforts to stop global warming and limit damaging climate change, which particularly threatens developing countries and the poor and vulnerable. The Albanian Prime Minister strongly supported the view that it was vital to reach international agreement on a new commitment period under the Kyoto Protocol at the meeting United Nations Framework Convention on Climate Change (UNFCCC) meetings in Copenhagen in December 2009.

Country context

Albania ratified UNFCCC in 1995 and has the status of a non-Annex I Party. Recently, Albania ratified the Kyoto Protocol as well. The Government of Albania has taken considerable steps toward the implementation of the UNFCCC requirements, such as preparing the First National Communication (FNC), a Technology Needs Assessment (TNA) and compiling the National Action Plan (NAP) to address climate change, with UNDP/GEF support. The Second National Communication (SNC) to the UNFCCC was recently realized.

According to the FNC, Albania is a relatively low net emitter of greenhouse gases (GHGs), with relatively low carbon dioxide (CO₂) emissions per capita, mainly due to the fact that over 90% of electricity is generated by hydro-sources. The energy sector contributes more than 60% of total emissions. Relatively high CO₂ emissions on a per-GDP basis are explained mainly due to high energy intensity. Based on the predictions for future emissions, by 2020 total emissions will rise by more than five times. Although Albania has made no commitments to reduce GHG emissions, the NAP aims to curb their growth.

Major commitments under the UNFCCC

By becoming a party to the UNFCCC, Albania has accepted a number of commitments which include, *inter alia*, to:

- Develop, periodically update, publish and make national inventories of anthropogenic emissions by sources and removals by sinks of all GHGs not controlled by the Montreal Protocol available to the Conference of the Parties of UNFCCC.
- Formulate, implement, publish and regularly update national and, where appropriate, regional programmes containing measures to mitigate climate change.
- Communicate information related to implementation of the UNFCCC to the CoP, in accordance with Article 12.

After the completion of the FNC, Albania secured “add-on” support from UNDP/GEF. Through this project, the climate change team that prepared the FNC has completed a TNA Report. At the start of the project, in 1998, a climate change office was established in the Ministry of Environment. This office serves not only for UNDP/GEF project implementation but is also responsible for the implementation process of the UNFCCC, serving as the national focal point and a possible nucleus for a national UNFCCC secretariat/committee in the future. A Programme Steering Committee has also been established that oversees all projects and activities within the framework of the UNFCCC. This informal committee includes high-level participants from all major governmental and non-governmental stakeholders. A technical-level national climate change team with three thematic working groups (on GHG emission inventories; GHG abatement measures; and vulnerability and adaptation) has been established.

Legal framework in support of implementation of the Kyoto Protocol and the Clean Development Mechanism

- Law No. 9334 dated 16.12.2004 on: “Ratification of Kyoto Protocol (KP) from the Republic of Albania,” and Law on Amendments to the Law No. 9385, dated 4.5.2005 “On Forests and Forest service”.
- The Ministry of Environment, Forestry and Water Administration (MoEFWA) is the responsible National Entity for implementation of the Kyoto Protocol in the Republic of Albania.
- Forest definition for the purposes of the Kyoto Protocol/Clean Development Mechanism (CDM) projects Law No. 9890, dated 19.03.2008. Amendments to Law No 8934, dated 5.9.2002 on “Environment Protection”, give the responsibility to the Minister of Environment of Albania to issue rules and procedures for hosting CDM projects in Albania, including Memoranda of Understanding and Agreements with the Governments of Italy and of Denmark. Other CDM-related agreements include with the World Bank Bio-carbon fund, and with Austrian Technical Cooperation.

Current Institutional Framework for CDM

Designated National Authority: The Government of Albania appointed the Climate Change Unit of the Ministry of Environment as the Designated National Authority (DNA). The basic functions of the DNA are to decide sustainable development criteria; confirm voluntary participation of the project participants; and confirm the sustainable development contribution of the project and issue Letters of Approval for the purposes of validation and registration under the CDM. The Ministry of Environment, Forests and Water Administration has responsibility for UNFCCC and Kyoto Protocol matters, and the DNA, through a Resolution of the Minister of Environment, was formally nominated to UNFCCC Secretariat in June 2005, upon the ratification of the Kyoto Protocol by Albania.

The Climate Change Programme/Unit is assigned to provide substantive support to the DNA. The scope of its responsibilities includes:

- providing substantive support to the Ministry for the implementation of the UNFCCC and Kyoto Protocol, including DNA functions;
- acting as focal point for UNFCCC and Kyoto Protocol, with responsibility for management and implementation of climate change projects: (National Communication; mitigation and adaptation projects);
- mobilizing resources (new projects for implementation of the UNFCCC and Kyoto Protocol); and
- developing a package of rules and procedures for CDM project approval and the associated support framework. This is being drafted and will be formalized soon.

Assistance on institutional capacity building

World Bank BioCarbon Fund

- Assisted Natural Regeneration Project (ongoing)
- Facilitation of Kyoto Protocol ratification and DNA establishment.
- Facilitation of the process for “forest definition” for the purpose of CDM projects.
- Baseline setting and monitoring methodology for an Afforestation/Reforestation (A/R) Land Use, Land Use Change and Forestry (LULUCF) Emission Reduction Purchase Agreement (ERPA) negotiation.

Italian Government

- Capacity building activities (ongoing):
- Legal and Institutional support
- CDM potential, Project Idea Note (PIN) development, feasibility studies.

Austrian Development Assistance

- Building Albania's capacity to access Carbon Finance (ongoing).
- Legal and institutional framework set-up for the DNA.
- Standard baseline studies (energy, forests).
- Increasing awareness of advantages of carbon finance.
- CDM strategy.

UNDP MDG Carbon Facility

- Identification of CDM projects with high sustainable development impact (ongoing)

Current situation with CDM

CDM potential identified:

- Approx: 2500 kilotonne CO2 equivalent per year through an A/R CDM project.
- New methodology approved. Project AR-AM003 for Albania's assisted natural regeneration of forests (Project Design Document (PDD) developed; pre-validation and validation performed; Emission Reduction Purchase Agreement (ERPA) signed; project registered as CDM).
- 7 PINs for Small Hydro Power Plants (SHPPs) developed. 2 PDDs developed through Austrian assistance.
- A portfolio of 11 CDM projects are identified under the Memorandum of Understanding with Italy, and a tendering procedure is finalized for selection of companies to carry out feasibility studies.
- Work on sectoral baselines: Power sector (final draft) and Forest sector feasibility study (in progress).
- Reduce transaction costs; better estimate ER, prepare the PDDs faster.

Summary of climate change dimensions

This annual report summarizes the government's progress on activities to reduce greenhouse gas (GHG) emissions and adapt to climate change impacts during the past years. This report provides an overview of climate change policies and programmes across Albania. Some of these programmes have already been implemented, while others are being developed in consultation with stakeholders and/or leading experts. To address the climate change related issues, the Government of Albania has formed a partnership with the United Nations Development Programme (UNDP), and supported by the Global Environment Facility (GEF), Austrian Technical Cooperation and other donors, is implementing a series of projects in the area of climate change mitigation (energy efficiency, renewable energy, carbon financing) and adaptation (adaptation policies in the Drini-Mati river deltas, carbon neutral territories). The Swiss and Italian Governments are supporting the creation of a functioning market for solar water heating.

The Ministry of Environment, Forestry and Water Administration and UNDP in November 2009 released two national reports: "The Second National Communication of Albania to the United Nations Framework Convention on Climate Change" and "Albanian Policy Paper for Carbon Finance". The reports represent the culmination of the work of a team of experts over a three-year period. Albania's Second National Communication to the UNFCCC presents an assessment of Albania's present situation with regard to climate change. It also provides scientific information and evidence as valuable input for policy-makers in long-term development planning for relevant sectors. The report shows that GHG emissions in Albania in 2000 totalled 7619.9 Gg. The main contributing sectors were Energy (44.0%), followed by Agriculture (27.1%) and Land Use Change and Forestry (21.6%). The share of land use change and forestry is being significantly reduced, while the shares of energy and waste are rising. Among energy subsectors, transport is the fastest growing sector.

GHG emissions per capita in Albania were 2.47 t CO₂ equivalent, which is 4 to 5 times lower than the average of industrialized countries. This is due to generally low energy consumption, with more than 90% of electricity being produced by hydropower plants and most energy being consumed as electricity. Two development scenarios have been built for the abovementioned sectors: a baseline scenario, which considers the development of the sectors without mitigation efforts, and an abatement scenario, which considers the implementation of a set of prioritized measures, aiming to reach a reduction of GHG emissions of 48% by the year 2025.

The report highlights that adaptation measures are needed, together with legislative, regulatory, and institutional frameworks, to prevent negative effects of climate change and also to identify new methods and technologies. Climate change is expected to bring significant effects in all sectors analysed, with energy being the most sensitive one. Rising temperatures, changes in the amount of precipitation, and variation in humidity, wind patterns and the number of annual sunny days could affect both consumption and production of energy. The two reports have been produced in the framework of the UNDP Albania Climate Change programme, supported by the Global Environment Facility and Austrian Development Agency, and implemented by UNDP Albania.

Projects and programmes

Together, the Government of Albania and UNDP have committed to support the use of renewable energy sources, protect biodiversity, and streamline commitments to international environmental conventions, and specifically those related to Biodiversity, Climate Change and Land Degradation. UNDP supports the Climate Change Unit within the Ministry of Environment Forestry and Water Administration.

The Climate Change programme, as mentioned above, works with the Ministry through producing the necessary reports to the UN Framework Convention on Climate Change (UNFCCC) and its Kyoto Protocol. The reports enable the Government to sell its carbon credits to industrialized countries that produce excess carbon emissions through the Clean Development Mechanism (CDM). This particular type of foreign investment, called 'Carbon Finance', also allows Albania to continue reducing its own carbon emissions for further credits to sell on the international market.

UNDP promotes solar water heating in the marketplace, with a project that foresees the installation of 70 000 m² of solar panels in Albania, with a cumulative GHG reduction potential of 1.5 million tonne over the next 20 years. UNDP, through the Climate Change Programme and GEF, is addressing the first ever attempts in Albania at climate change adaptation with a project aimed at protecting vulnerable ecosystems and local livelihoods by identifying and mainstreaming adaptation response measures into development programming in the Drini-Mati River Deltas. By implementing the Stockholm Convention, Albania is also taking measures to eliminate or reduce the release of Persistent Organic Pollutants (POPs) into the environment, and to manage contaminated sites.

The Governments of Albania, of FYR of Macedonia, and of Greece are working together to protect globally significant biodiversity in the Prespa Lakes Basin. The three countries are integrating and coordinating ecological, economic and social goals to reduce pollution in the lakes, and are introducing environmental management practices.

In addition to the technical and financial support given to Government counterparts, UNDP provides support to a number of non-governmental and community-based organizations working on specific environmental concerns. UNDP is also supporting eco-tourism as a way to protect the environment and cultural assets while providing economic and job growth opportunities for primarily rural communities.

Table 1. UNDP projects in the area of Energy and Environment in Albania

Project name	Theme
Building Capacity to Access Carbon Finance in Albania (June 2007–December 2009)	Frameworks and strategies for sustainable development
Enabling Albania to prepare its Second National Communication in Response to its Commitments to the UNFCCC (March 2005–December 2009)	Frameworks and strategies for sustainable development
GEF Small Grants Programme (open-ended)	Conservation and sustainable use of biodiversity
Identification and prioritization of environmental hotspots in Albania (January 2008–July 2010)	National and sectoral policy and planning to control emissions of ozone-depleting substances and persistent organic pollutants
Identification of adaptation response measures in the Drini–Mati River Deltas (May 2008–May 2012)	Conservation and sustainable use of biodiversity
Integrated Ecosystem Management in the Prespa Lakes Basin of Albania, FYR-Macedonia and Greece (September 2006–December 2011)	Conservation and sustainable use of biodiversity
Strengthening capacities in the Western Balkan countries to address environmental problems through remediation of high priority hot spots - Albanian Component (October 2007–March 2010)	National and sectoral policy and planning to control emissions of ozone-depleting substances and persistent organic pollutants

Project Design Document for afforestation and reforestation project activities

Forest situation

Albania's forests cover 36% and pastures cover 14% of the total land area. The primary responsibility for forest and pasture management belongs to the Ministry of Environment, Forests and Water Administration. The forest ownership rights have been delegated to communes (local level) according to case-by-case decrees of CM during 2008: Amendment to the Law No. 9385, dated 4.5.2005 on "Forests and Forest Service". A National Strategy on Forests Management (2001) and Biodiversity Strategy (1999) address the sustainable management of forests. Degradation has been identified as a major issue for the country, mainly due to uncontrolled grazing. Illegal cutting, mainly for energy needs in rural areas, is another phenomenon.

Two projects, starting from 1996, have supported the transfer of forests to the communities, and sustainable forest management. The Albania Forestry Project (AFP) (1996–2004) supported the transfer of user rights and management of forest and pasture from the state to local communities. It was followed up by a Natural Resource Development Project (NRDP), 2005–2011, with the main objective of supporting expansion of community-based management of the natural resource of the country. As part of this project, the BioCarbon Fund of the World Bank agreed with the Ministry of Environment, Forests and Water Administration to pilot the first CDM project for Albania.

Project objective

To increase carbon sequestration through afforestation and reforestation of highly degraded land, which will also lead to enhanced sources of livelihood and incomes in poor rural areas, reduced soil degradation, improved water quality, and conservation of biodiversity

Project overview

This is the first CDM project for Albania and the area projected to be afforested is 6272.36 ha of degraded land; CO₂ emission reduction of approximately 280 000 t CO₂ (in the period 2002–2017) to be transferred to the World Bank as Emissions Reductions (ER). The project methodology is new and has been approved by CDM Executive Board (EB) as project AR-AM003. The period of crediting

will be 20 years, with possibility of renewal. The NRDP, funded by a credit from the International Development Association, will support the carbon sequestration project in its first years. Project participants are MoEFWA and the BioCarbon Fund of World Bank. The validation process was realized in 2009, with registration of the project on 2 January 2010.

The role of the communal Forest and Pasture User Associations (FPUAs)

The Carbon Sequestration project is based on Forest and Pasture User Associations (FPUAs). An FPUA will make an agreement with a commune to use a part of the communal forest land under the management of the commune for the purposes of the project. FPUAs will be responsible for the planting and tending of the trees. FPUAs will be the recipients of the payments for sequestered carbon received from the World Bank.

Where and how will the money be transferred?

The state owns the tradable rights in sequestered carbon because it owns the sequestered carbon as a component of a tree. The state would contract to sell those rights—carbon credits—to the World Bank through the ERPA. The World Bank would pay the price for the carbon credits into a bank account which will be directly under control and management of the FPUAs involved in the project.

How the local villages can benefit from the carbon payments.

The carbon payments will be transferred from the Carbon Association to each commune in the FPUA account; the amount of carbon payments will depend on the area in hectares planted or managed by each commune. The FPUA should produce a management plan for the expenditure of the carbon payments for environmental and social improvement (a re-investment fund) within the villages involved in the project, proportionally to the land made available to the project in each village. The FPUA should maintain proper accounts of any expenditure of project-related payments and will permit the Commune, the DFS and officers of the CFCUA to check on and audit those accounts.

Climate change impacts and dimensions

Climate change effects in Albania

Climate change effects were felt since the late 1990s in Albania, more precisely in 1997, when the winter came with very little or no snow at all. It used to snow a lot on the Albanian highlands, but in 1997 it snowed just once and very little. All of March and April were hot, and with very little rain. Since 1997, winters in Albania have become shorter and milder, whereas summers have become longer and hotter. Droughts in summer and sometimes even in autumn, and then sudden floods, have become more frequent.

The coasts have started to erode along almost the entire Adriatic coastline in Albania due to sea level rise—in some places the sea has advanced more than 50 m inland, destroying the coastal forests and vegetation, and increasing the salinity in the lagoons and fields near the coast. Sea level rise has wreaked havoc on the beautiful Mediterranean Pine forests that cover the Adriatic coast in Albania. Most of the trees that are found on the coastal margins are dying from increasing salinity. In other places, especially in villages near the coast, the salinity in the soil and in the water wells has increased significantly, damaging the small rural economies along the coast.

The climate change effects have increased the number and the intensity of fires in Albania. During 2006–2007 there were 352 major fires that burned throughout Albanian parks and forests, burning entire ecosystems and pastures. In some areas you could drive for tens of kilometres without seeing a single tree unburned—the fires devastated entire forests sometimes. The fires can be attributed to a higher temperature in summer, prolonged droughts and earlier melting of snow on the mountain caps. The climate change has brought mild winters, which have favoured the growth of tropical plants even in Albania. Seasons have shifted a lot too—trees used to lose

their leaves by October and then flower in March, but now they lose leaves late in November and flower sometimes even by the end January.

Status of assessment and research on climate change

Documents

Several studies have been carried out regarding climate change issues, and also numerous assessments of climate vulnerability. Further information can be found on the following Web sites, as well as by following up on the references provided at the end of this report.

Web sites

www.ccalb.org/
www.ccalb.org/Progress%20Annual%20Report%202006_Climate%20Change%20Programme_Albania.pdf
www.ccalb.org/public%20awareness/pa_publications.htm
www.moe.gov.al/
sgp.undp.org/
www.ccalb.org/activities/activities_TNA.htm
archive.rec.org/REC/Programs/ClimateChange/Docs/country-assessment-report-albania.pdf
www.wbc-inco.net/attach/Report_Albania.pdf
www.esmap.org/filez/pubs/121200934336_FINAL_CESVAP_Albania_Climate_Vulnerability_Assmnt-English.pdf
www.undg.org/toolkit/tool.cfm?id=245

Legal framework and national policies related to climate change

Except for the laws on ratification of the UNFCCC and the Kyoto Protocol from Albania's parliament, there are no laws that address explicitly the issue of climate change. Because the energy sector emits a significant share of GHG emissions, the sector has been the focus of analysis and recommendations for climate change mitigation. In addition, the most relevant laws for climate change are those applying to the energy sector. The legislative framework on energy in Albania currently comprises a relatively large number of different items of legislation.

Laws related to climate change

Law on Energy Efficiency and Renewable Energy Sources (No. 9372 of April 27, 2005)

This is the most important law for climate change in general and GHG mitigation in particular. It focuses on promotion of energy efficiency and energy conservation, creation of an energy efficiency fund, energy efficiency labelling, and promotion of energy audit schemes. This law establishes the economical use of energy sources, the establishment of more reliable energy supply conditions, as well as the minimization of impact on the environment.

Law on Power Sector (No. 9072 of May 2003)

It assures the conditions of electricity supply to consumers, efficient functioning of the electricity market and adjusts the power sector to market economy conditions.

Law on Electricity (No. 7962 of July 1995)

This law specifies the conditions for activities in the power sector and the rights and duties of all physical and legal persons involved in such activities.

Law on Regulation of Power Sector (No. 7970 of July 1995)

This law prescribes the establishment of an Energy Regulatory Body (ERE) in the power sector and defines its duties. According to this law, ERE is responsible for tariff regulation and licensing in the power sector.

Law on Energy Conservation in Buildings (No. 8937 of September 2002)

This law declares that the design and construction of buildings should meet the necessary technical parameters for conservation, saving and efficient use of energy.

Governmental Decree for Energy Building Code

The elaboration of the Energy Building Code began in 1998, based on the National Agency for Energy (NAE) in collaboration with the Albania-EU Energy Efficiency Centre (EEC) and the other institutions of the sector.

Governmental Decree for Strategy of Energy (No. 424 of June 2003)

This governmental decree approves the National Strategy of Energy until 2015. According to the decree, the Ministry of Industry and Energy and the NAE are appointed to update this strategy every two years.

National policies and measures to limit GHG emissions

The first GHG emission abatement analysis for Albania was performed in the frame of Albania's FNC. This analysis consisted of developing two GHG scenarios: a GHG baseline scenario and a GHG abatement scenario. The development of both scenarios was made by utilizing a number of assumptions based on the macro-economic projections of the country as a whole, as well as in the development plans of the economic sectors taken in particular.

The GHG abatement measures and technology options identified under Albania's FNC have undergone a prioritization process through Albania's TNA exercise carried out under the Top-Up Phase of the Climate Change Enabling Activities. The TNA is a complex process. It is a continuation of the work already carried out or identified or recommended under Albania's FNC and through other activities to enhance technology transfer.

This assessment of technology needs has been made through a sector-by-sector approach, starting with the energy sector, which, according to Albania's FNC, makes the most significant contribution to the overall GHG emissions inventory. The assessment also covers other sectors such as LULUCF, agriculture, waste management and industrial processes. The software used for the development of energy and transport baseline emissions scenario was Long-range Energy Alternatives Planning (LEAP) (version 95.0). Concerning the non-energy sectors, the 1996 revised IPCC methodology was used for the development of baseline emission projections, although an exception was made for the solvent use sector. The predictions for non-methane volatile organic compounds (NMVOC) emissions by the year 2020 are made according to UN Economic Commission for Europe CO₂ R₂ d₂ nated I₂ nformation AIR (CORINAIR) methodology. The development of GHG abatement analysis for the energy and transport sector is based on LEAP and GACMO7 software. For the other sectors, the analysis is more qualitative (quantitative analysis was not possible).

Many new strategies and actions plans have recently been adopted by the Government of Albania that will affect GHG abatement in Albania, and therefore both scenarios (baseline and abatement) need to be updated and improved. Albania has addressed the mitigation and adaptation measures through the National Climate Change Strategy, which consists of a set of priorities for action in order to integrate climate change concerns into other economic development plans. This strategy is elaborated in the frame of Albania's First National Communication. The abatement scenario of emissions foresees the introduction and implementation of different options mainly focused on energy saving and energy efficiency measures. A basket of 25 GHG mitigation measures for the energy and transport sector is proposed in the frame of this study, which are then analysed in terms of cost and benefit. In terms of resource mobilization, the package of project ideas was developed under the TNA exercise. Two projects have been sent to GEF for funding and seem to

be successful (one is a project on Market Transformation for Solar Thermal Water Heating in Albania). GEF has recently approved a Project Development Facility (PDF B) and the pipeline entry of the full project. Another project on building adaptive capacities for representative vulnerable systems is underway. The rest of the project idea notes serve as good background for the potential projects to be carried out under the CDM.

The National Energy Strategy (NES) was drafted and approved in June 2003 by the Government of Albania, according to Decision of the Council of Ministers, No. 424, dated June 26, 2003. The NES, which was prepared as an integral part of the National Strategy for Social and Economic Development (NSSSED), has already integrated many findings and outputs from Albania's FNC and TNA. The Strategy for the Development of the Energy Sector is a document that analyses and recommends changes by 2015 that must be undertaken in Albania to increase the security of the energy supply and the optimization of the energy resources to meet the local demand and achieve sustainable development. The specific objectives of the NES are:

- to increase the security and reliability of the energy supply in general and electricity in particular, at national and regional levels;
- to establish an efficient energy sector from financial and technical aspects;
- to establish an effective institutional and regulatory framework and restructuring of energy companies;
- to increase energy efficiency in generation, production and final use of energy sources, aiming to minimize pollution;
- to optimize the supply system with energy sources based on least-cost planning principles with minimal pollution; and
- to increase considerably investments in the energy sector through capital enhancement by international financial institutions, as well as private capital.

The policy objectives and strategies for forest development are:

- Ensure the territorial integrity, ecology and biodiversity of forests and pastures.
- Promote and support sustainable management of forest resources and pastures.
- Improvement and strengthening of ties with the market economy.
- Involvement of local stakeholders and users in conservation and forestry development.
- Institutional and legal reform of the forest service at national and local level.
- Establishment of an Environmental Fund for initial funding to ensure investment in environmental projects. Environmental resource management through a clear legal framework, implemented through a permit system to monitor and better control protected areas, protection of flora and fauna, water resources and rights to the waters (especially a planning system and strengthening waterbasin authorities).

Protection of forests.

- Includes promotion of forest management and conservation of natural pastures in order to ensure biodiversity and ecotourism development; rehabilitation of degraded forests to return the relevant forest stations to optimal condition; transfer of forests and pastures to local government units; and measures for illegal logging.

Land protection.

- Increase by 5% by 2010 the level of forest coverage in the areas most seriously affected in whole; ban all unlicensed extraction of river gravel; and strict restrictions imposed on licensed excavations.
- Maintain and increase biodiversity.
- Further increase of the surface of protected areas in 15% of the territory by the year 2014 (ensuring representation of all ecosystems and implementing elements of Pan-European

Ecological Network activities to support objectives and species action plans); preparation of management plans for protected areas within the existing priorities for 2011.

Policy options for wood energy

Management and sustainable development of multifunctional forest resources will be realized through the following objectives:

- Continuous protection and rehabilitation of forests.
- Conservation of forests through the reduction and cessation of illegal logging.
- Preservation and rehabilitation of forest ecosystems and damaged pastures through reforestation and rehabilitation of degraded forests.
- Organization of a modern forest cadastre, providing the basis for an updated forest wealth assessment, in terms not only surface area and volume, but also the property value at all levels of management. Development of a cadastre sector equipped for modern field techniques, including geographical information systems (GIS).
- Preservation of nature and promotion of ecotourism. Develop a national plan for tourism development in forest and in certain categories of protected areas and start its implementation. Increase capacity to host ecotourism model homes through investment in rural areas and tourist guide training.
- Promotion of sustainable and multifunctional use of forest resources.
- Promotion of social and protective functions of forests.
- Promotion of the production potential for non-timber products.
- Encouraging private activities carrying out works and services in state forests by specialized firms for execution of manufacturing activities and services. Liberalization of tariffs on industrial wood and fuelwood products from production forests.
- Transfer of right-to-use and ownership of forests and pastures to local government. Improve the legal framework, especially to encourage active involvement in the management of forests and pastures by local users and local governments.
- Creation of municipal forest administrations in relation to local governments.
- Continuation of institutional reform in order to establish effective and appropriate operation both centrally and at base level. Establishment of a Regional Forest Directorate, responsible for strengthening state institutions, improving the structure of forest administration, and facilitating versatility all levels.

Despite the progress made in mainstreaming climate change issues, there is a significant need to continue the process of incorporating climate change in national planning and policy. In addition to GHG reduction measures, there is a significant need to address adaptation, mainly in the most vulnerable areas of the country and in the most vulnerable sectors, such as water resources, agriculture and tourism. From the institutional point of view, there is a significant need to institutionalize the national communication process in order to ensure a sustainable and qualitative reporting process.

Proposed areas for cooperation

Gaps and problems identified

Institutional and legal

- Lack of a strong national institutional framework for CDM.
- Lack of formalized national rules and procedures for the CDM process in Albania, including:
 - structure of the CDM approval process;
 - sector-specific sustainable development criteria; and
 - financial resources for DNA staff.

Technical and capacity related

- Lack of national capacities to write PINs and PDDs.
- Limited knowledge of advantages of carbon financing in economics of investment, such as evaluating internal rates of return.
- Lack of data for estimation of baseline emissions.
- Lack of some methodologies (e.g. no approved CDM methodology for district heating or transportation projects).
- Low baseline for GHG emission for the energy sector due to lack of access and high reliance on hydro sources (95%).
- Attempts to get involved in carbon financing have started relatively late compared with other countries, thereby limiting investor interest.
- Limited internal resources to support the PDD, or even PIN preparation.

Albania's strategy in the carbon market

Although entering relatively late into the CDM market, Albania still has opportunity to undertake project-based transactions, by:

- working to properly establish an effective domestic framework to support CDM projects;
- working aggressively in parallel to develop a carbon project portfolio; and
- given the uncertainties of the market structure beyond 2012, prioritizing project development based on an assessment of the risks and benefits of engaging in the current market.

Issues for consideration

It is important to position Albania as a good CDM project developer with effective institutional arrangements for the approval process. A simple national structure and simple approval procedures are important, as are least-cost options to promote CDM. Although the carbon market is an emerging market with lots of uncertainties, those who take the risk get access to the opportunities offered through financial mechanisms (CDM). The role of the private sector is crucial to the CDM process, so its involvement from the inception phase is critical. The usefulness of including the PIN within national approval procedure is the ability to issue "No-objection letters". Development of CDM projects should focus initially on sectors that have proven methodologies.

Next steps to be followed

The improved management of forests and pastures provides environmental benefits at regional, national and international levels, thus suggesting that the users of the land should also be rewarded for such services. This requires further investments to provide knowledge of environmental costs and effects. The aim would be to secure sustainable and worthwhile income to the forest and pasture users. One activity would be to extend the area of the project on "Assisted Natural Regeneration of Degraded Lands in Albania" in the frame of approved methodology for afforestation and reforestation projects.

Land degradation has been identified as a major issue for Albania. Land is eroding quickly, and the landscape looks devastated. It is essential that vegetative cover be established soon, to halt erosion. There are more than 150 000 ha of abandoned agricultural land, as well as degraded shrub and grazing land, that can be improved through assisted natural regeneration. Albania has long experience of working with local communities. Natural regeneration can be assisted by cooperation between the project (hosted by the Ministry of Environment, Forests and Water Administration of the Government of Albania), the communes and the forest user associations of the communes. Natural regeneration will be enabled by excluding grazing from the project area;

bare lands will be afforested through complementary planting. The baseline scenario is continuous degradation and erosion through unsustainable grazing.

The output of the project is long-term managed reforestation, contributing to soil conservation and improvement of water quality, generation of income in rural communities, production of wood and non-wood forest products (nuts, fruits and medicinal plants).

Relevant alternatives (baseline scenario) identified in the context of the project activities without the CDM component are: reintroduction of degraded lands into the agricultural production cycle; continuation of the existing and historical land use leading to further degradation; and implementation of a project as an assisted natural regeneration activity without being registered formally as an A/R CDM project activity.

A proposed modified approach in following up

As noted earlier, the BioCarbon Fund, administered by the World Bank, has agreed to purchase emission reductions in communal forests in Albania after a negotiation of an Emission Reduction Purchase Agreement (ERPA) at a price of US\$ 4.4 per tonne of CO₂. The biological growth in areas included is measured by local evaluators, subject to validation from an independent Designated Operational Entity (DOE). The same procedures to seek official Carbon Credits which could be used for meeting Kyoto Protocol commitments are, at least initially, not envisaged. There are two reasons for not following the same procedures as in the existing project on assisted natural regeneration through forestations:

- The selection of areas to be included is severely constrained by the Kyoto Protocol definitions.
- The procedure for verifying carbon credits under the World Bank Carbon Fund is excessively bureaucratic.

However, the verification of the carbon effects from existing methodology would be used as a strong indicator of the level of continuing carbon benefits which would be realized from carbon sequestration in areas similar to but outside of those included in that project. Consequently no continuing payment for carbon would be paid but the project should also include a pilot scheme for identifying voluntary carbon credits and alternative verification strategies.

An interesting possibility would be to assess interest by European private companies in contributing funding for carbon sequestration, by paying for implementation of sustainable participatory management plans. They may be interested in such an arrangement in view of the public image benefits of simultaneously supporting poverty reduction benefits and CO₂ reductions, as indicated by measurements of carbon benefits based on the NRDP component. The new project could also investigate the possibility of negotiating Voluntary Carbon Credits provided by some of the voluntary carbon credit arrangements, such as Voluntary Carbon Standard (VCS) thus making it possible to receive tradable Carbon Credits which would provide forest and pasture users with additional and continuous income.

Insufficient scientific data on payments for environmental services needs to be resolved by close cooperation with FAO

Another important project for the future in Albania could be a project on “payments for environmental services” (PES). Payment to the forest and pasture users for providing environmental services requires that these possible environmental services be verified. Assisted natural regeneration provides one example on how carbon sequestration could be verified and payments given to those who manage their forest and pasture for global environmental benefits.

References

- Government of Albania. 2002. National Strategy on Socio-Economic Development.
- MoEFWA. 2004. Compendium of Environment Legislation, Republic of Albania.
- MoEFWA. 2000. Biodiversity Strategy and Action Plan, Republic of Albania.
- MoEFWA. 2000–2002. State of Environment Report, Republic of Albania.
- MoEFWA. 2002. National Assessment Report for the World Summit on Sustainable Development, Johannesburg, Republic of South Africa.
- MoEFWA. 1993 (updated and approved 2002). National Environmental Action Plan for the Republic of Albania.
- MoEFWA/UNEP. 2004. Environmental Diagnosis of Coastal Zone, Republic of Albania. Map.
- UNDP. 2002. Environmental Performance Review, Albania.
- USDA. 2003. Albanian Watershed Assessment Project.
- World Bank. 2004. Environmental and Social Management Framework for World Bank Projects World Bank. 1996–2003. Albanian Forestry Project with Multiple Small-Scale Subprojects: A Toolkit.

References on status and work by national research institutions on research for assessment of climate change

- Acceleration of the cost competitive biomass use energy purpose in the western Balkan countries. 2006–2007. *The Energy in Albania* [Albania-EU Energy Efficiency Centre (EEC) Newsletter], no. 37 (Dec. 2006): 4 (www.eec.org.al/newsletter%2037.pdf) and no. 38 (Mar. 2007): 1–2 (www.eec.org.al/newsletter%2038.pdf).
- BiomAlba. 2009. Analysis and study of the feasibility of a biomass chain in Albania. Paper presented at a Workshop and study visit, Bologna, Italy, 16–20 December 2008. See: www.biomalba.net/allegati/Workshop%2016-20%20december%202008.pdf
- Ciavola, P. 1999. Relation between river dynamics and coastal changes in Albania: an assessment integrating satellite imagery with historical data. *International Journal of Remote Sensing*, 20(3): 561–584.
- Clean Development Mechanism, Project Design Document Form For Afforestation And Reforestation, Project Activities (Cdm-Ar-Pdd), Version 01. Expertenkonferenz, Albanien: Wettbewerbsfähige Regionen durch Energieeffizienz und Ressourcenschutz, 21–22 November 2008. www.suedosteuropagesellschaft.com/.../tagung_landnutzung_albanien.pdf
- Country Assessment Report on Climate Change October 2005. archive.rec.org/REC/.../ClimateChange/.../country-assessment-report-albania.pdf
- Elvin Toromani. 2009. Potential of biomass energy in Albania. Lecture presentation. Available at www.ics.trieste.it/media/160435/07_toromani.pdf
- Hjortberg, A.S. & Wingqvist, G.O. 2008. Albania environment and climate change analysis. Desk study prepared for SIDA by Environmental Economics Unit, University of Gothenburg, Sweden. www.hgu.gu.se/Files/nationalekonomi/EEU/Helpdesk/EnvPolicyBrief/2008/Environmental%20policy%20brief%20Albania.pdf
- Karaj, Sh., Rehla, T., Leisa, H. & Müllera, J. 2010. Analysis of biomass residues potential for electrical energy generation in Albania. *Renewable and Sustainable Energy Reviews*, 14(1): 493–499. Available at linkinghub.elsevier.com/retrieve/pii/S1364032109001580
- Kopali Albert, Mankolli Hysen, Abazi Uran & Shumeli Arjan. 2009. Biomass composting and agronomic and environmental effect evaluation. *Journal of International Environmental Application & Science*, 4(3): 339–343. Abstract available at: www.jieas.com/volumes/vol091-3/abs09-v4-i3-17.pdf

- Roland Cela & Aheron Himzo. 2009. Analysis of renewable energy and its impact on rural development in Albania. AgriPolicy – Enlargement Network for Agripolicy Analysis. Work Package WP2 (Studies), Deliverable D2.2 (Study 2). Available at www.euroqualityfiles.net/AgriPolicy/Report%202.2/Agripolicy%20WP2%20D2%20Albania%20Final.pdf
- Spahiu, Bashkim & Spahiu, Yllka. No date. Environmental effects of energy use in Albania and public awareness, education and training on climate change. Institute of Hydrotechnical Research and Design, Tirana, Albania, Available at www.balwois.com/balwois/administration/full_paper/ffp-824.pdf
- Technology Needs Assessment (Top-up Phase) (March 2002–March 2004). April 2002. Capacity building on estimation of climate change impact. Assoc. Prof. Dr Eglantina Demiraj Bruci, Head, Climatological Division, Hydrometeorological Institute.
- UNDP Albania - Climate Change Programme/Unit. No date. Technology Needs Assessment (Top Up Phase (March 2002–March 2004). See: www.ccalb.org/activities/activities_TNA.htm Full report available at: ttclear.unfccc.int/ttclear/pdf/TNA/Albania/AlbaniaTNAreport.pdf
- Validation of the CDM-Project: Assisted natural regeneration of degraded lands in Albania report No. 1252921, 02 October 2009. Tüv Süd Industrie Service GmbH, Carbon Management Service, Munich, Germany.
- World Bank. No date. An assessment of climate change vulnerability, risk, and adaptation in Albania's energy sector. World Bank, Energy Sector Management Assistance Program (ESMAP). See: www.esmap.org/filez/pubs/121200934336_FINAL_CESVAP_Albania_Climate_Vulnerability_Assmnt-English.pdf

ARMENIA

Artur Gevorgyan

Summary of climate change dimensions

Currently humanity is facing climate change challenges that require urgent action at national, regional and global levels. Recognizing the importance of addressing human-induced climate change and its possible negative consequences worldwide, the United Nations Framework Convention on Climate Change (UNFCCC) was adopted in 1992, and its Kyoto Protocol in 1997. Armenia ratified the UNFCCC in May 1993, and the Kyoto Protocol in December 2002. According to Articles 4.1 and 12.1 of the UNFCCC, Armenia regularly follows its commitments, as defined for the Non-Annex I Parties to the Convention, and participates in international cooperation and regional programmes related to climate change.

First National Communication to the UNFCCC

In order to fulfil the basic provisions of the Convention, Armenia has implemented the project "Armenia – Country Study on Climate Change", which was funded by the Global Environment Facility (GEF). Within the scope of its First National Communication (FNC), Armenia has carried out the following activities (Ministry of Nature Protection/UNDP Armenia/GEF, 1998):

- Inventory of anthropogenic emissions and sinks of GHGs according to the IPCC 1995 Guidelines.
- Identification at national level of the regions, natural ecosystems and spheres of activity that are most vulnerable as a result of expected climatic changes.
- Development of education, training of specialists, raising awareness of climate change-related issues, and enhancement of public opinion to these problems.
- International cooperation and information exchange on issues of relevance to fulfilment of commitments to UNFCCC.
- Submitting information to the Conference of Parties of UNFCCC on national measures for the fulfilment of the Convention and their results.
- Cooperation directed to reduction of anthropogenic emissions of GHGs in all sectors of the economy, especially in the energy sector, together with transport, industry, agriculture, forestry and waste removal.

The National Greenhouse Gas Inventory of Armenia considered five of the six main modules of the IPCC Guidelines. These were energy, industrial processes, agriculture, land use change and forestry and waste. In the GHG emissions and removals calculations both the IPCC defaults and local factors were used, with regard to the specific conditions of Armenia. The activity data were applied according to the data provided by the national and sectoral statistics.

For the land use change and forestry sector of the national GHG inventory it was estimated that CO₂ emissions and removals were caused mostly by the forestry sector. Based on estimations for 1990, CO₂ emissions from the forest sector were 80 Gg while absorption was 697 Gg, resulting in a net absorption equal to 617 Gg. Forest and grassland conversion was assumed to be insignificant, and abandoned managed lands continued to degrade and not accumulate carbon, thus they were not included in the calculations.

According to the FNC, some shift was expected of existent landscape zones in the country. In particular, the lower border of the forest belt was envisaged to move upward by 100–200 m, with vulnerability of forests expected to increase as a result of insect infestations. It was noted that the change in the lower forest border could be expected to take place over the next 50–100 years, while some upper forest expansion would be possible by slow natural forest regeneration.

To reduce adverse consequences of climate change in natural ecosystems of Armenia, the following adaptation measures were outlined: creation of optimum forest cover, up to 20.1% of the territory of the Republic, by 2050; allocation of reserves and specially protected natural territories for the reduction of general anthropogenic pressure on vulnerable ecosystems; introduction of endangered species into similar habitats, promoting survival in case of climate change; preservation of the genetic stock of the most vulnerable and valuable species by keeping and cultivating *ex situ*, preservation of genetic resources in seed banks, etc.; and monitoring of vulnerable ecosystems.

It was calculated that with annual planting of 5 300 ha of forest it might be possible to expand forest cover from the current 11.2% to 20.1% by 2050, increasing the forest area by 266 500 ha. The study of historical, archaeological and paleobotanical data on past forest cover of the country has also revealed that it was three times bigger than today, comprising about 35% of the total territory in the first millennium B.C.

Capacity building in Armenia for technology needs assessment and technology transfer for addressing climate change problems

The objective of the second phase of the Armenia – Country Study on Climate Change project was capacity building in Armenia for solution of climate change problems in the following main directions:

- Identification of the priority technological needs of Armenia's economic sectors in the areas of reduction of GHG emissions, development of proposals for key technologies and assessment of possibilities for their practical application, development and assessment of specific technological projects.
- Development of proposals for adaptation measures and technologies for mitigation of the consequences of climate change for the environment and economic sectors.
- Determination of the technological needs for the development of the monitoring system and strengthening of the national monitoring network for participation in the Global System of Climate Monitoring (GSCM).

The report (Ministry of Nature Protection/UNDP Armenia/GEF, 2003) incorporated the results of activities, including analyses of GHG emissions, technological needs and technologies for reduction of GHG emissions. A fair amount of attention was paid to the assessment of the potential and use of alternative sources of energy. In addition, the report presented the results of vulnerability assessments for water resources, agriculture, environment and population health, as well as the technological needs and adaptation technologies for mitigation of climate change impacts in the areas mentioned, as well as incorporating information on the activities of the national hydrometeorological service and conditions of the monitoring network, analysis of the trends of climatic anomalies and assessment of their impact on the economy. Priority needs for strengthening the environmental observation and monitoring networks and wider participation in the GSCM were identified.

Finally, it discussed the conditions for technology transfer to the country (investment environment, financial market, legal framework, etc.), and presented the results of activities for developing and strengthening national capacity (organizational, informational, human) for assessment of technological needs and transfer of technologies, as well as activities for increasing public and stakeholder awareness and interagency coordination in climate change-related issues.

National capacity self assessment for global environmental management – UNDP project

First, the national capacity needs were assessed for implementation of UN Conventions on Biodiversity, on Climate Change and to Combat Desertification (thematic assessment). The

activities implemented and existing capacity was assessed from the viewpoint of ongoing processes and sectoral development plans of the country, as well as relevance for implementation of Convention decisions (UNDP/GEF, 2004). The second stage covered capacity assessment in seven cross-cutting areas:

- Organizational activities.
- Approximation of legislation to the requirements of Convention.
- Taxonomy and monitoring.
- Database development.
- Submission of national reports to the Convention Secretariat.
- Staff training and awareness projects development and implementation.
- Internal and international cooperation.

The selection was based on two considerations:

- all the seven areas were considered to be common relative to the three conventions, enabling application of synergistic possibilities of conventions for capacity needs assessment, and to correspond to the national development priorities and peculiarities; and
- all seven areas are tools for environmental policy: their improvement and harmonization will contribute to the development and implementation of a unified environmental protection policy at national and global levels.

Capacity building for improving the quality of GHG inventories (Europe/CIS region) – UNDP project

The goal of this regional project was to build on the inventory work undertaken for FNC in preparation for Second National Communications. Technical and institutional capacity would be sustained. As a result of the regional project, GHG inventories prepared under enabling activities for subsequent National Communications should be of a higher quality than those prepared for the initial national communications. Immediate objectives of the Project were the following:

- Strengthened national arrangements for compiling, archiving, updating and managing GHG inventories.
- Sustainable institutional process created.
- Enhanced technical capacity for preparing national inventories.
- Improved emission factors and methods.

A programmatic approach to building capacity was developed. The approach, while regional in design, was flexible enough to meet national needs. Aside from certain common activities, countries were free to choose to participate in some or all of the remaining project activities, consistent with national priorities. This gave countries the opportunity to focus allocation of resources on national arrangements or emission factors, as appropriate. After conducting the key source analysis, the countries reviewed the regional summary table at the project finalization workshop in Croatia (Zagreb, March 2002) and agreed upon a key-source inventory that will include up to four IPCC subcategories:

- Fugitive CH₄ emissions from oil and gas (Energy Sector).
- CH₄ emissions from solid waste (Waste Sector).
- CO₂ from transport (Energy Sector).
- CH₄ emissions from enteric fermentation (Agriculture Sector).

Although the LULUCF sector was not included as a priority sector in the frame of a regional project, further application of the IPCC Good Practice Guidance (GPG) for LULUCF, 2003, allowed the inclusion of the LULUCF sector in key source and sink analyses for GHG inventories. Recognizing the importance of the LULUCF sector within the overall GHG inventory, the project team focused on building the appropriate competence for the sector

consistent to GPG LULUCF, 2003, requirements. It promoted improving the available expertise in the sector from the level recorded at the beginning of the Regional Project (www.nature-ic.am/ccarmenia/download.php?fid=842765244), which applied the IPCC95 Guidelines. In addition, expertise for the LULUCF sector was not available at the beginning of the project in the country. However, in spite of the short time available and resources allocated to the sector, following recruitment of a National Expert on LULUCF, it was possible to gain significant achievements, namely:

- Review and apply to the extent possible, the IPCC 96 Guidelines, and GPG LULUCF, 2003.
- Improve a number of Activity Data resources thanks to application of complete territorial coverage of broad Land Use Categories, including Forest Land, Cropland, Grassland, Wetland, Settlement and Other Land, consistent with GPG LULUCF, 2003.
- Improve around 30 Removal Factors for Average Annual Timber Increment by species and forest categories for baseline year 1990, as well as about 15 local Basic Wood Density factors and 14 Conversion Factors for Carbon Fraction of Dry Matter.
- Develop the National Inventory Manual chapter for LULUCF, etc.

Technical assistance to Armenia, Azerbaijan, Georgia and Moldova with respect to their global climate change commitments – TACIS project

This regional project had the objective of building capacity for hosting CDM projects in the beneficiary countries, including assistance in forming the institutional infrastructure required to support CDM projects, and development of a portfolio of CDM projects, which would fit into the sustainable development strategy of the beneficiary country. Also covered were awareness raising among key policy-makers, the business community and the general public on issues related to UNFCCC and the Kyoto protocol, and on development opportunities and issues with respect to CDM and GHG mitigation, as well as local capacity development in GHG emission forecast modelling and assessment of sectoral GHG mitigation potentials and options and assistance to the beneficiary countries in developing their national climate change strategies, including mitigation and adaptation measures. The project outcomes include (EC, 2006):

- organization of a series of local and international awareness raising seminars on Kyoto Protocol and CDM for representatives of key ministries, project partners, private companies and NGOs;
- development and update of the CDM project pipeline;
- development of CDM Manual for Armenia;
- development and maintenance of the project website (www.cdm.nature-ic.am) which serves as a channel for dissemination of project materials and CDM-related information;
- development of a draft procedure for CDM project submission and approval; and
- development of a baseline study for grid-connected small renewable projects and three CDM project design documents.

In addition, within the scope of the TACIS project, Fichtner GmbH & Co. KG in co-operation with the Armenian Office of the Regional Project successfully prepared the Project Design Document (PDD) for a Community Small-Scale Afforestation/Reforestation CDM Project in the Lori region of Armenia. The proposed project has been designed in a way to have clear community based-orientation, focusing on Lori: one of the largest, but poorest, administrative regions of the country. Other important aspects related to the favourable nature and climatic conditions were also taken into account for the identification of the proposed A/R project activity location.

Together with tackling various technical issues related to development of the first carbon forestry project in Armenia, open and voluntary project participation has been ensured, raising awareness among the rural communities and Lori Territorial Administration (Marzpetaran) level. To facilitate this, a number of community meetings and field visits were undertaken to promote community

involvement and to identify eligible A/R sites. As a result, 25 rural communities of RA Lori marz signed Memoranda of Cooperation with Fichtner for joint implementation of the project.

The proposed project was planned as a group of relatively small areas located in different low income communities in Lori region, covering ca 1000 ha. The project area limitation was based on methodology applied for small-scale projects, since the project was expected to result in net anthropogenic GHG removals by sinks of less than 8 kilotonne of CO₂ per year. Although during project development there was no requirement for inclusion of forest adaptation objectives, they were nevertheless integrated in the project development process (Gevorgyan, 2008) to the extent possible to ensure efficiency of forest mitigation measures. However, it was not possible to proceed further for finalization of the project PDD, mainly due to lack of time and available funds, as well as there being no potential project donor identified.

The socio-economic impact of climate change in Armenia – UNDP project

The project findings prepared by Stockholm Environmental Institute (USA) stressed the following social impacts: an increased incidence of illness from heat waves as temperatures rise; a shortage of water and an increase in electricity tariffs as competing needs collide; food shortages or increased food prices as agricultural productivity falters; and an increased incidence of dangerous and damaging landslides, mudflows and floods as dry soil and deforestation coincide with extreme storms. The project report suggested very serious economic impacts, with business revenues, jobs, household income and consumption all falling as agricultural production declines and electricity tariffs grow. Smaller-scale economic losses in electricity generation and damage to forests are expected.

Changes to temperature and precipitation on this scale over the half century were forecast to have far-reaching effects on many aspects of social and economic life in Armenia. The scale of climate change damages will depend on individual, business and—most importantly—state responses through adaptive policies in the country. Social and economic impacts from climate change (high temperatures and heat waves, water shortages, reduced agricultural production, reduced electricity production and price increases, damage to forests, and natural disasters) were described in detail and subjected to socio-economic analyses, including potential adaptation measures to address each type of damage.

Mitigating impacts of climate change through forest protection, management and restoration in southern Caucasus – BMU/WWF project

The regional BMU/WWF project embraced three Southern Caucasus countries and consisted of four modules: two on forest carbon sequestration (A/R CDM projects, including one in a mountain area in Lori, Armenia; one addressing climate adaptation in mountain forests in Georgia; and one for developing a regional climate forest adaptation plan for southern Caucasus (Anon. 2008)). An investment of € 4.8 million has been envisaged in support of a project on climate mitigation through forest protection, management and restoration in three countries. Besides mitigating climate change, the project was also expected to generate new economic opportunities for the rural population in the three pilot areas, introduce alternative energy options, reduce economic losses due to unsustainable land use practices, and enhance the local biodiversity.

Project partners in Armenia were the Climate Change Centre of the Ministry of Nature Protection, “Hayantar SNCO” of the Ministry of Agriculture and the “Armenia Tree Project” NGO. The chosen project area included sites in two communities in the Lori Region: Margahovit and Spitak. Additional benefits included were the creation of local job opportunities for communities, and enhanced biodiversity values. To disseminate the results, national workshops were scheduled at the end of the project, involving representatives from other ministries, local and regional authorities, and the international donor community.

The total country project budget was €1 460 000, with the biggest allocation to local investments (71%), followed by CDM registration, local labour costs and project management. According to the logistics of the regional project, the Project Design Document should be developed in Armenia and submitted for validation. According to the timetable of the project, it was expected that the CDM project would be registered and operational by the end of 2009. Although some forest planting activities were implemented, unfortunately, it could not lead to A/R activities under the CDM framework. In fact, despite availability of funds, the project developers could go no further than the outcome obtained during the TACIS initiative on development of PDD for “Community small-scale afforestation/reforestation project in Lori, Armenia” in 2006.

Second National Communication to the UNFCCC

The Second National Communication was prepared in accordance with the guidelines for national communications of Non-Annex I parties (2003) by the Ministry of Nature Protection of Armenia, with financial support from GEF and the support of the UNDP in Armenia. The Second National Communication had a larger scope related to climate change problems, considering the developments in the country, as well as new developments under the convention after the submission of the First National Communication. Activities identified in Second National Communication included:

- Improve and expand the database of the national GHG inventory and analyse the emission trends for 1990–2006.
- Assess the potential for reducing GHG emissions in various sectors of the economy.
- Develop climate change scenarios for Armenia.
- Assess the vulnerability of ecosystems and climate-dependent sectors of the economy and define priority adaptation actions for mitigating the consequences of climate change.
- Assess the impact of the expected intensification of dangerous hydrometeorological phenomena and the related early warning needs
- Assess the improvement needs of national systems for systematic observation and climate monitoring.
- Enhance knowledge and public awareness concerning climate change issues, and contribute to improving the qualifications of climate change specialists.

The application of the IPCC GPG for LULUCF, 2003, has enabled not only the recalculation of the national GHG inventory results for 1990, but also revealed that rapid changes in the emission/removal balance had taken place in the LULUCF sector (from -36.0 Gg in 1990 to +1563.6 Gg in 2000), which is mainly attributed to unsustainable forest management and agricultural land use practices. In fact, the forest sector itself has become a large source of GHG emissions, instead of normally being a carbon sink. Table 1 below presents the data by broad land use categories for the baseline (1990) and inventory (2000) years. It should also be stressed that a number of difficulties related to the lack of a national forest carbon accounting and reporting framework, institutional arrangements, as well as scarcity of forestry and land use data, made it a challenge to meet IPCC GPG for LULUCF, 2003, requirements. Therefore, taking into account the importance of LULUCF as a key sector for the GHG inventory, there is a strong need for the further capacity building in this sector. The SNC has also outlined the climate change impact in relation to forest cover of the country. In particular, more than 17 000 ha of forest (5–5.5%) is expected to disappear because of unfavourable forest growth conditions. In addition, areas highlighted were worsening phytosanitary conditions, mass outbreaks of diseases and pests, and greater risk of forest fires, all of which will lead to negative impacts on forest ecosystems. The idea of optimal forest cover suggested by the FNC has not been further supported by SNC. Within the scope of the “Enabling activities for the preparation of the Armenian’s Second National Communication to the UNFCCC” a UNDP/GEF project, the “Implementation of the Kyoto Protocol’s Clean Development Mechanism in Armenia” was published.

Table 1. Land use, land use change and forestry (LULUCF) sector GHG inventory results for 1990 and 2000.

Land Use, Land Use Change and Forestry sector	Net GHG fluxes (Gg CO ₂ e.)	
	1990	2000
LULUCF, Total	-736.0	1 563.6
5A Forest Land	-837.1	441.0
5B Cropland	-134.0	501.8
5C Grassland	173.4	598.4
5D Wetland	71.2	27.7
5E Settlement	-9.4	-5.2
5F Other Land	0.0	0.0

Adaptation to climate change impacts in mountain forest ecosystems of Armenia – UNDP/GEF project

The Ministry of Nature Protection of Armenia has requested technical assistance from UNDP and GEF to address impacts of climate change on mountain forest ecosystems in the south-eastern, Syunik region of the country. It is expected also to bring in its own resources in addition to those of the GEF to achieve the project main goal in Syunik, namely to adapt forest ecosystems to climate change. This has involved reducing or removing anthropogenic pressures, and adopting policies and practices that will directly assist species in forest ecosystems to adjust to climate change. The project is going to operate at multiple levels:

- to integrate climate change risks into the critical decision-making points of forest conservation and management at national and sectoral levels;
- to develop institutional capacities for planned adaptation by improving climate risk monitoring, data management, knowledge and skill-set development for scenario-based decisions; and
- to demonstrate effectiveness of adaptation measures that are designed and implemented by the local stakeholders at sub-national level.

The project will therefore focus on strengthening the enabling environment for mainstreaming climate change risks in forest and protected area management planning, developing associated technical capacities, as well as piloting on-the-ground adaptation measures at target sites.

The following three main outcomes of the project are expected:

- The enabling environment for integrating climate change risks into management of forest ecosystems is in place.
- Forest and protected area management in the Syunik region integrates pilot adaptation measures to enhance adaptive capacity of mountain forest ecosystems.
- Capacities for adaptive management, monitoring and evaluation, learning, and replication of project lessons are developed.

Response measures focused on reducing the effects of the three main climate-induced threats to forest ecosystems: pest outbreaks; forest fires; and increased fragmentation. Lessons learned are expected to be replicated in other mountain forest ecosystems in central and northern Armenia. Within the scope of the project the publication on “Forest Biodiversity of Armenia’s Syunik Marz and Global Climate Change” (Anon. 2008b) was prepared in Armenian with a short English summary, aiming to present the rich forest biodiversity of the region, covering current and expected vulnerability to global climate change impacts, as well as a brief introduction to the adaptation measures for climate change impacts.

Status of assessment and research on climate change

Systematic climate observations

The main institution responsible for systematic hydrometeorological and climate observations in Armenia is the State Hydro-Meteorological and Monitoring Service (Armstatehydromet SNCO) of the Ministry of Emergency Situations of RA. It operates in accordance with the provisions of the Law on Hydro-Meteorological Activities (2001) and provides actual hydrometeorological data to relevant authorities and the general public.

Hydrometeorological observations have been conducted in Armenia since 1881; however, initially they were not done systematically. The establishment of a proper network of observations dates from the 1920s. At present, there are 42 meteorological and 3 special stations (Figure 1) in the country. In addition, 79 hydrometeorological observation points, a hydro-meteorological observatory, and seven hydrological stations with 92 water gauge observation points operate within the system.

Yerevan, Sevan and Amasya meteorological and one aerological (Yerevan) stations are part of the global communications system (GCS). In addition, 20 stations are included in the intergovernmental hydrometeorological network of CIS countries. During 2000–2007, Armstatehydromet, as a result of cooperation with the World Meteorological Organization (WMO), was able to introduce a number of new systems and equipment. Technologies relevant to new international standards assist in obtaining and sharing data. The WAREP code for communicating rapid notifications on dangerous hydro-meteorological phenomena is being introduced. Since 2007, efforts have been under way for transition from the traditional letter-digit codes to the Binary Universal Form for the representation of meteorological data (BUFR), which is widely used worldwide. The “TV-inform” system installed in Armstatehydromet in 2002 was replaced by the “Mitra” system in 2004, which was integrated with UniMAS and RETIM2000 systems.

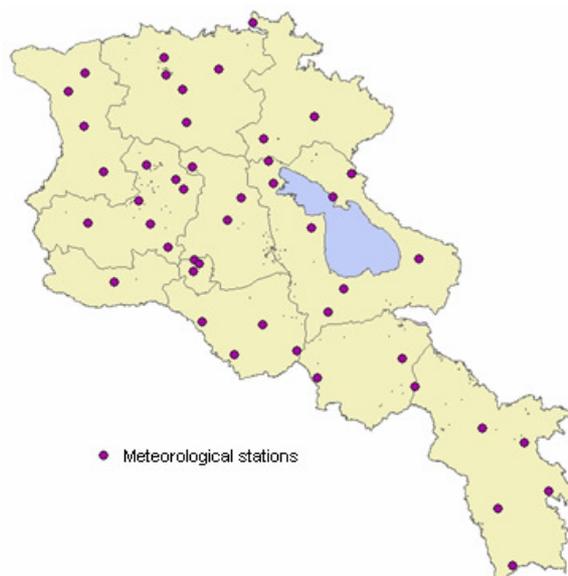


Figure 1. Meteorological monitoring network in Armenia

Data from observations at all the meteorological stations are collected and stored in the Armstatehydromet central database, using the CLICOM system. A few years ago, following IPCC recommendations, RClimDex software was introduced for data quality control. Sinop software is already being used and new software has also been introduced. Additionally, the KH-01 software for decoding and binary representation of meteorological data has been developed and introduced.

Governmental and public organizations, as well as the general public are consumers of the hydro-meteorological information provided by Armstatehydromet. Many important climate parameters are available free of charge, including:

- maximum and minimum temperatures of the previous day; quantity of precipitation; meteorological phenomena; clouds; depths of snow cover on the national territory;
- weather forecasts for all regions for up to 5 days;
- characteristics of heliophysical and radiation regime; and
- forecasts of hydrological phenomena.

Since 2003, Armstatehydromet has been included in the European Climate Assessment & Dataset (ECA&D) and regularly provides observation data, which are used by IPCC for calculating indexes used for the assessment of climate change. According to the procedures defined by WMO, the data from observations at Yerevan aerological and Amberd stations are regularly communicated to the relevant centres. Since 2007, Aragatz, a high-elevation station (3226 m), the only station in the region operating at over 3000 m of altitude, is included in the GCOS Surface Network (GSN). The station has been operational since 1929 and has enormous significance for climate change studies in the region.

Armstatehydromet has provided data to the Global Precipitation Climatology Centre (Offenbach, Germany) established within the framework of the Global Climate Observation System (GCOS), where studies of precipitation distribution and its global changes are conducted based on the collected data. Armstatehydromet, in partnership with the German Meteorological Organization (DWD), is implementing the programme “The use of CM-SAF satellite products for monitoring of the climate on Armenia’s territory”.

Research activities and programmes on climate change

The research activities in Armstatehydromet are conducted by the Climate Study Centre, which has four departments: Climatology; Digital Modelling of Hydrometeorological Processes; Global and Regional Climate Change Studies; and Applied Climatology. The climatology department processes data from the 280 stations and observation points for various periods, as well as publishing books where the climatic resources of the territory are presented in detail. In the department for digital modelling of dangerous hydrometeorological phenomena, dynamic statistical models for short-term forecasts are developed and further elaborated. The algorithms developed are used for assessment and forecasts of precipitation, river flows, mudslides, yield of agricultural crops, droughts, and atmospheric pollution. The global and regional climate change studies department develops models for climate change scenarios in Armenia, also reflecting changes occurring at a global scale. Long-term forecasting methods (monthly, seasonal, annual) have been developed for various purposes. The applied climatology department develops methodologies for forecasting hydrological and water resources, agro-meteorological, bio-meteorological, alternative energy-related phenomena, as well as frequency and intensity of droughts.

Studies and programmes on climate change issues in Armenia are basically devoted to vulnerability, assessment of climate change consequences and developing adaptation measures. Since 2008, the following studies have been financed from the state budget:

- Dynamics and nature of changes to Armenia's flora as a result of the spread of invasive plant species and global climate change.
- Study of zoo-complexes of Armenia's invertebrates in order to identify climate change biomarkers and to develop the scientific basis for monitoring biodiversity vulnerability.
- Assessment of water, temperature and radiation resources for crop yields, based on modern principles.
- Assessment of the changes to water resources of large basins in Armenia.
- Development of methodologies for assessing and forecasting drought conditions and the losses to agriculture crops, and the piloting of these methodologies in Armenia's regions.
- Development of a methodology for forecasting crop yields in Armenia.
- Testing of the methodology for assessment and forecasts of Lake Sevan active water exchange zone, as a pre-condition for the management of the lake's water resources.

In spite of limited funding for forest/climate change study, independent research on “Assessment of carbon sequestration of Pallas pine plantation in the north-eastern region of Armenia” was initiated and conducted by Artur Gevorgyan from 2002–2007. The goals and objectives of the study were first presented as a poster in the Youth Sector of the exhibition area of the FAO XII World Forestry Congress, Quebec City, Canada, in September 2003. Later the research results were directly applied in development of the first A/R CDM project in Armenia under the TACIS initiative in 2006. During 2008–2009, for assessing climate change impacts on various sectors and developing adaptation measures, the following pilot projects were implemented with UNDP support:

- Assessment of climate change impact on the economy of Shirak region. Adaptation measures for mitigating the impact of climate change on the region's economy were proposed. Public opinion on climate change was assessed, and public awareness building measures were implemented.
- Assessment of climate change impacts on Lusadzor community of Tavush region. In Lusadzor, as a target community of the UNDP community development project (UNDP Armenia, 2009), the current and forecasted changes to the climate were analysed in detail, the impacts influencing community development projects were identified, and priority adaptation measures were identified.
- Comprehensive assessment of climate change impact on water resources in Marmarik River basin. The project assessed the changes to the water resources of Marmarik river basin up to 2007, forecasted the vulnerability of water resources by 2030, 2070 and 2100, assessed the potential financial-economic losses from the water system as a result of climate change, and developed adaptation measures with economic justifications in four categories: without significant expenditures; with minimum expenditures; economically justified measures; and long-term measures (UNDP Armenia, 2009b).
- Climate change-related risk assessment in Ararat region. Based on the natural disasters assessment project implemented in the region with UNDP financing, as well as the results of a survey conducted in more than 30 communities of the region, the dynamics and risks of dangerous hydrometeorological phenomena and natural disasters in the Ararat region were analysed within the context of climate change impacts, and measures for mitigating the impacts were proposed.

Proposed areas for cooperation

Development of a National Forest Carbon Accounting and Reporting System in Armenia

The role of the forests in the carbon cycle is significant. However, in order to account and report the changes occurring in the forest carbon balance, a proper system should be established and maintained at the national level. Elaboration of the national GHG inventory for the LULUCF

sector has revealed new priorities, as well as a number of challenges faced by the country in order to meet relevant IPCC reporting requirements for the LULUCF sector.

The SNC of Armenia under the UNFCCC has identified the LULUCF sector as a key category and Forest Land as a significant sub-category within the overall national GHG inventory for 2000 year. At present, it is urgent to improve the quality of the GHG inventory related to forestry and to strengthen forest mitigation measures at various levels. In particular the project may cover the following aspects:

- Development of guidelines and a common reporting framework designed for all forest land users, including state forest management units, specially protected nature areas (i.e. forest reserves, reservations, national parks, etc.), communities, the private sector, and individual landholders.
- Ensuring the data can identify relevant forest management activities and land use changes, including deforestation, afforestation and reforestation.
- Providing systematic training for project beneficiaries at local, sub-national and national level.
- Making recommendations for forest inventory for short-term and long-term improvement.
- Building capacities for Reducing Emissions from Deforestation and Forest Degradation (REDD) initiatives.

Feasibility study to foster A/R project development under the CDM

Carbon forestry projects can demonstrate mutual benefits for the mitigation of climate change and achieving sustainable development in developing countries. During the first commitment period of the Kyoto Protocol, LULUCF projects are limited to A/R activities. However; in spite of obvious benefits, A/R activities have not yet gained much popularity, which is in part attributed to complexity in developing and implementing such projects.

Normally, in order to foster A/R CDM project development in a country, it is strongly encouraged to undertake feasibility studies, aiming to review existing forest policy, legal, institutional and technological capacities. More importantly, possible barriers should be identified and measures to mitigate them addressed.

The necessity for such study was still very high in 2006, when the draft Project Design Document for Community Small-Scale Afforestation/Reforestation project in Lori region of Armenia was developed under the TACIS regional initiative. However, due to lack of time and resources, many aspects related to a detailed feasibility study were omitted at that time, expecting to return to them once a potential donor had been identified. Surely, without a comprehensive country feasibility study, efforts to foster A/R CDM projects may not be successful, unless properly covering the following aspects:

- Identification of investment, institutional and technological barriers, as well as barriers due to prevailing (first of its kind) practices, ecological and social conditions.
- Preparation of adequate measures to address identified barriers.
- Consideration of climate change impact for establishment and further tending of forest plantations, aiming to increase their adaptive and mitigation capacities.
- Ensure development of human capacities to deal with carbon forestry projects.
- Assessment of potential for eligible pilot A/R sites to be used under the CDM project activity.

Integration of forest adaptation and mitigation objectives securing forest development

The current UNDP/GEF project “Adaptation to Climate Change Impacts in Mountain Forest Ecosystems of Armenia” has provided good opportunities for cooperation with the forest sector in relation to climate changes issues. The project is also envisaged to serve as a model not only for other parts of the country, but also for the region. It embraces key forest actors at different levels,

addressing three aspects of forest adaptation: pest outbreaks, forest fires and increased forest fragmentation.

However there may be some opportunities for strengthening forest adaptation capacities, as well as ensuring that forest mitigation measures are in place. The combination of forest adaptation and mitigation objectives is not only possible, but also co-beneficial for forest development. Therefore, the implementation of complementary activities would allow maximization of the positive experience gained by the pilot project implementation, for subsequent dissemination to other interested parties. It does not necessarily mean affecting ongoing project implementation structures, but rather carrying out additional activities in parallel with other current UNDP projects. In particular, the following areas could be addressed:

- Redefining management priorities for the use and conservation of vulnerable forests areas.
- Adjusting the ways and methods of forest utilization in climate change-affected sites.
- Developing recommendations for improved silvicultural treatments, fostering more adaptable forest species and hybrids, as well as affecting local soil preparation, tree planting and tending techniques.
- Highlighting areas to reduce GHG emissions associated with forest degradation and deforestation, as well as strengthening forest carbon sequestration capacities.
- Raising public awareness of the impact of forest management on carbon balance and forest mitigation capacities, in line with forest adaptation considerations.

However, it is recognized that it will not be easy to alter the UNDP/GEF project already in implementation by adding new priorities or bundling with other parallel projects.

References

- Anon. 2009. Overview. Implementation of the Kyoto Protocol's Clean Development Mechanism in Armenia, 2009. Report of "Enabling Activities for the Preparation of Armenia's Second National Communication to the UNFCCC" Project UNDP/GEF/00035196. Available at: www.nature-ic.am/ccarmenia/download.php?fid=685031814
- Anon. 2008. Securing natural carbon sinks and habitats of special significance for adaptation to the consequences of climate change. BMU Caucasus Proposal.
- Anon. 2008b. Forest Biodiversity of Armenia's Syunik Marz and Global Climate Change, 2008. Available at: www.nature-ic.am/ccarmenia/download.php?fid=179757464
- EC. 2006b. Technical Assistance to Armenia, Azerbaijan, Georgia and Moldova with respect to their Global Climate Change Commitments, EC EuropeAid/111523/C/SV/Multi- Lot No.2 Final Report, September 2006, 31p. Available at web site: www.nature-ic.am/ccarmenia/download.php?fid=326695383
- EU. 2006a. Clean Development Mechanism Handbook for Armenia. The European Union's TACIS programme for Eastern Europe, the Caucasus and Central Asia. Available at: www.nature-ic.am/ccarmenia/download.php?fid=227584152
- Gevorgyan, A. 2008. Integration of Climate Adaptation and Mitigation measures is Co-Beneficial to Forest Development. Presentation at International Forest Adaptation Conference, IUFRO/SLU/FAO, 25–28 August, 2008, Umea, Sweden. Available at: www.forestadaptation2008.net/51746@122028/en/
- Ministry of Nature Protection/UNDP Armenia/GEF. 2003. Capacity building in the Republic of Armenia for technology needs assessment and technology transfer for addressing climate change problems. "Armenia - Country Study On Climate Change" Project, II Phase. Available at www.nature-ic.am/ccarmenia/download.php?fid=834618567
- Ministry of Nature Protection/UNDP Armenia/GEF. 1998. First National Communication of the Republic of Armenia under The United Nations Framework Convention On Climate Change, October, 1998. Available at www.nature-ic.am/ccarmenia/download.php?fid=291493448

- Second National Communication of Armenia under the UNFCCC. Final draft, English summary.
Available at: www.nature-ic.am/ccarmenia/download.php?fid=121137701
- SEI. 2009. The Socio-Economic Impact of Climate Change in the Republic of Armenia,
Stockholm Environmental Institute (USA)/UNDP project.
- UNDP Armenia. 2009. Armenia: Lusadzor Village Climate Change Impact Assessment.
Available at: www.nature-ic.am/ccarmenia/download.php?fid=121994435
- UNDP Armenia. 2009b. See: www.nature-ic.am/ccarmenia/download.php?fid=804357239
- UNDP/GEF. 2009. Adaptation to Climate Change Impacts in Mountain Forest Ecosystems of
Armenia, UNDP/GEF project. Inception report. Available at: www.nature-ic.am/ccarmenia/download.php?fid=818226157
- UNDP/GEF. 2004. [Report of] National Capacity Self-Assessment for Global Environmental
Management project. Project UNDP/GEF/ARM/02/G31/A/1G/99. Available at:
www.nature-ic.am/ccarmenia/download.php?fid=607138983
- UNFCCC. 2006. Project Design Document for “Community small-scale
afforestation/reforestation project in Lori, Armenia” by Artur Gevorgyan and Julia Funck,
November 2006. Available at: www.nature-ic.am/ccarmenia/download.php?fid=906419005

AZERBAIJAN

Ragim Ibragimov

Review of available information, and planned or implemented measures

The territory of the Azerbaijan Republic is 8.6 million hectare. The forest fund consists of 1 213 700 ha, with the forest cover being 989 300 ha. The forest range occupies only 11.4% of the Republic's territory. Forest management is performed according to the Forest Code and to the Environment Protection Law. All the forests of the Republic are State owned, and have significant water protection, soil protection and climate regulation functions.

The forests are distributed unevenly over the country: about 95% of them are located in the mountains and about 5% on the plains. In the mountains, forest cover varies from 18 to 43%, while in the lower regions it amounts to 0.5–2%. The Eastern beech (*Fagus orientalis*) plays an important role in the forest formation, and is present on 31.7% of the forest territory. Oak (*Quercus* spp.) is widespread, both in the mountains and on the lowlands and is found on 23.4% of the forest area; hornbeam (*Carpinus* spp.) grows in the mountains and piedmonts, and occupies about 26.0% of the territory. These three tree species are the main forest forming species and occupy about 81.1% of the entire forest territory.

The age indicators of the forests differ: in the mountain area, the average age is 86 years; on the lowlands it is about 40–60 years. The yearly average wood increment in the country is 1.5 million m³. The country's forests have a low average increment per hectare, which is explained by low forest density and poor productivity.

Nevertheless, all of the Republic's forests are of great value for their protective functions. Besides, these are stable ecosystems (when no anthropogenic influence is present); they are extremely well adapted to the specific soil and climate conditions, including natural climate variations. In the mountains, the forests prevent erosion and mud slide processes, and help to modulate river flows downstream. In the bottom-lands of Kura and Araz rivers (*tugai*), plantations perform shore protection and water preservation functions. On flat irrigated lands, the forest plantations serve as protection against the harmful action of water and wind. The forests are the source of non-wood forest products – nuts (walnut, hazelnut and almonds), fruit (apple, pear, plum, apricot, hawthorn, rosehips, barberry, etc.), mushrooms and berries, medicinal plants, tanning and colouring substances, etc. The forests serve as the base for the support of a biologically diverse flora and fauna.

In recent years forest destruction has become catastrophic; 261 000 ha of forest lands in the occupied territories have been practically destroyed due in part to overharvesting of fuelwood, which was the main source of energy for the majority of the refugees. This led to high levels of soil erosion.

At the present time, because of excessive exploitation, excessive cattle grazing, forest destruction and the use of poor irrigation methods, land degradation and desertification have become among the most important problems for Azerbaijan. This situation is caused by both economic and social factors: low population awareness; war; drought; and global climate change. The Ministry for Ecology and Natural Resources has taken considerable measures to combat desertification. The practical implementation of the National Forest Restoration Programme has begun. The execution of this Programme on one side of the Azerbaijani basin of the Caspian Sea in the Nabran region, where unique relic wooded lands (oak) are located, which are located in depressions below sea level, will contribute to climate change adaptation. In the opinion of scientists, this region is

especially vulnerable to potential climate changes. To preserve the natural biodiversity, the Samur-Yalama National Park is being created, with the help of the German Government.

Over the last few years global climate warming has become evident in Azerbaijan. Rainstorms, river flooding, floods, cold summers and weak winters are examples of that. In 2009, total precipitation in Azerbaijan's regions increased in comparison with previous years.

Azerbaijan, like other countries, takes certain measures against global climate warming. Against the background of climate warming, regional changes have also taken place. Such changes can be identified from the 100-year observation data of the 16 most representative meteorological stations. The trend analysis results show that over the 100-year period the air temperature increased by 0.5–0.6°C. During the period from 1961 to 1990, the increase in warming amounted to 0.3–0.6°C.

In 1992, countries of the world, realizing the reality of such threat, adopted the United Nations Framework Convention on Climate Change (UNFCCC) was adopted, and in 1997 countries adopted the Kyoto Protocol under this Convention. The goal of this Convention is the stabilization of the GHG concentrations in the atmosphere at such level that will prevent dangerous anthropogenic interference to the climate system.

The Republic of Azerbaijan ratified UNFCCC on 10 January 1995. Being a non-Annex 1 Party to the UNFCCC, the Azerbaijan Republic accepted the obligations on formation, execution and publication of national and regional programmes, which include measures aimed at climate change mitigation.

Taking into consideration the importance of this issue, which requires a serious and targeted approach, a Decree of the President of the Azerbaijan Republic, dated 30 April 1997, established the State Climate Change Commission for execution of obligations under the UNFCCC, with representation from 18 ministries and departments. The project financing was provided specifically to assist the country in the execution of the climate change studies within the framework of the UNDP/GEF programme. The Initial National Communication was prepared in 2000. This was executed by the Department of Hydrometeorology of the Ministry for Ecology and Natural Resources, and its purpose was to supply information related to climate change in Azerbaijan for the world community.

The Second National Communication (SNC) was submitted in 2002. The work was executed under this project in two different directions:

- The creation of a national cadastre of anthropogenic emissions and of GHG absorption.
- Assessment of the anthropogenic GHG emission reduction in different sectors of the economy and the development of recommendations for the execution of national policy in this sector.
- A study of the impact and vulnerability of ecosystems and of the most important economic sectors, and the development of climate change adaptation measures.

Review of the Conditions and the Work of the National Research Institutes on Studies that Evaluate Climate Change in the Forest Sector

There is no scientifically based information in Azerbaijan on climate change impacts on forest plantations, such as productivity, decreased survival ability or increased mortality during the last decades. The only work in this direction was performed within the framework of the National Climate Change Communications. The country participates in UNFCCC and its Kyoto Protocol, and consented to the implementation of about 40 projects.

Climate Change Assessment on the Forests of Azerbaijan

Warming was apparent in all natural zones of the country. Maximum warming was observed in the Greater Caucasus, Kura-Arazsky lowlands (0.5–0.65°C); the minimum was observed in the mountains of the Smaller Caucasus and in the coastal areas of the Caspian Sea (0.14–0.2°C). The dynamics of more than a century-long precipitation record for the Baku station shows that, approximately, precipitation has increased over the last 50 years. The trend analysis results show that if during the 1881–1997 period, annual precipitation increased by 21%, then in the years 1971–1997 the decrease amounted to only 12%.

Figure 1. Temperature change under five scenarios as a result of a doubling of carbon dioxide levels across Azerbaijan.

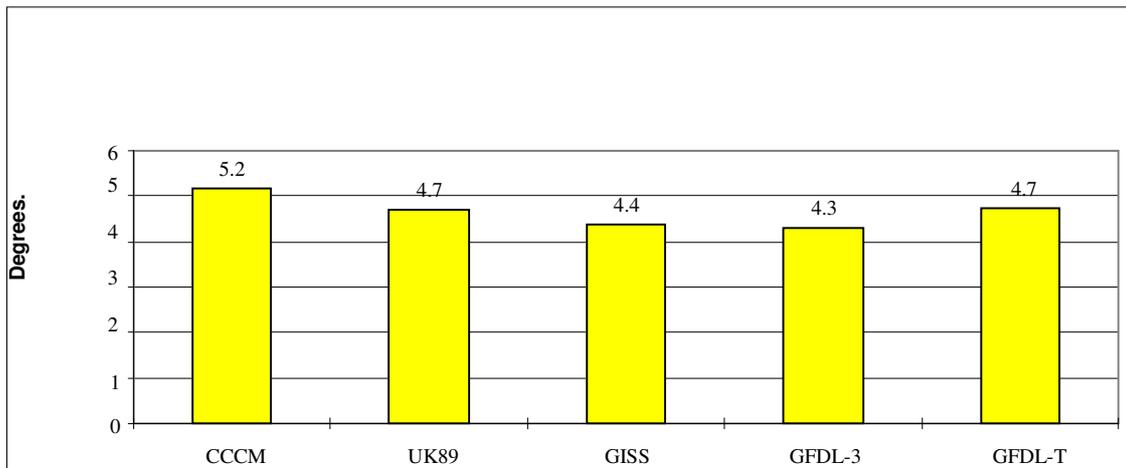
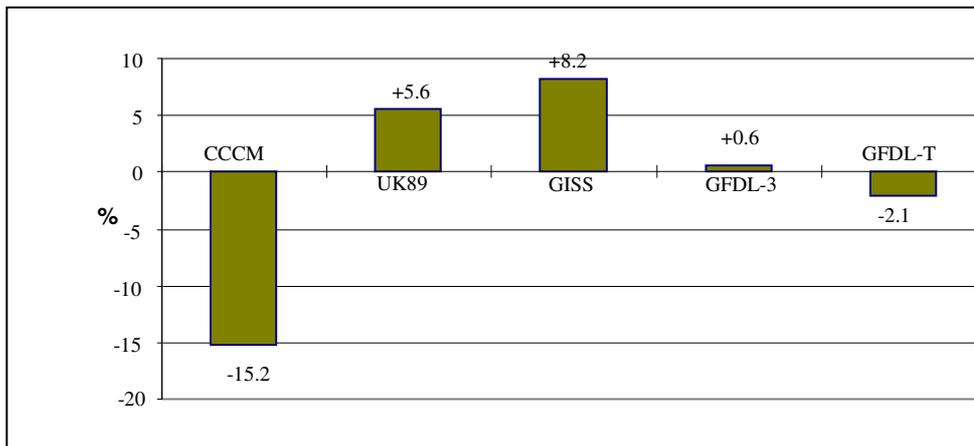


Figure 2. Precipitation changes under five scenarios as a result of a doubling of carbon dioxide concentration across Azerbaijan.



Potential opportunities for carbon dioxide absorption increase

How to best utilize the forest cover of Azerbaijan as a means to augment carbon sequestration is a question that requires a multifaceted response. Organizationally, this requires an increased level of forestry management, and detailed reporting of multiple advantages provided by the forests. The resolution of these tasks means significant increase in forestry-related expenses, and a need to find additional or alternative financing sources. The studies conducted showed that the carbon reserves of the wooded lands of Azerbaijan amount to 60 million tonnes, and the yearly

sequestration rate is 670 000 t. Analysis of results indicate a serious deterioration in the Azerbaijani forest fund over the last 10 years. The forests, disturbed by illegal harvesting, have lost their self-restoration ability. Reforestation and restoration of these forests implies significant cost and the implementation of a set of forest management measures that provide for effective use of the resource and its ecological potential. Initially, this requires the implementation of forest protection measures, expansion of forest restoration works and reconstruction of low-density and low-value plantations, coupled with improvement of the forest use system.

The execution of all these measures will allow optimization of the forest's age structure and increased productivity and, accordingly, will create the preconditions for increased absorption of carbon. These measures are forecast to additionally increase absorption by 6 670 000 t by 2025. The analysis shows that from the carbon accumulation point of view, the most important measures are an increased plantation density and the establishment of new forests. According to the calculations above, it is clear that the implementation of the forecasted forest restoration measures, the increase in integrity and biological productivity of the wooded lands, as well as the reduction of illegal forest harvesting, will result in the CO₂ absorption rate increasing by 1.5 times in the year 2025. The cost per tonne of CO₂ absorbed in 2025 in comparison with 2000 will decrease by approximately 30%. The reconstruction of low-density and low-value plantations will result in improved structure and content of forests, and the plantation of new wooded lands will allow reaching the optimal level of forests in this country. Table 1 reflects the forecast carbon dioxide absorption rates from the existing wooded lands and proposed new plantations.

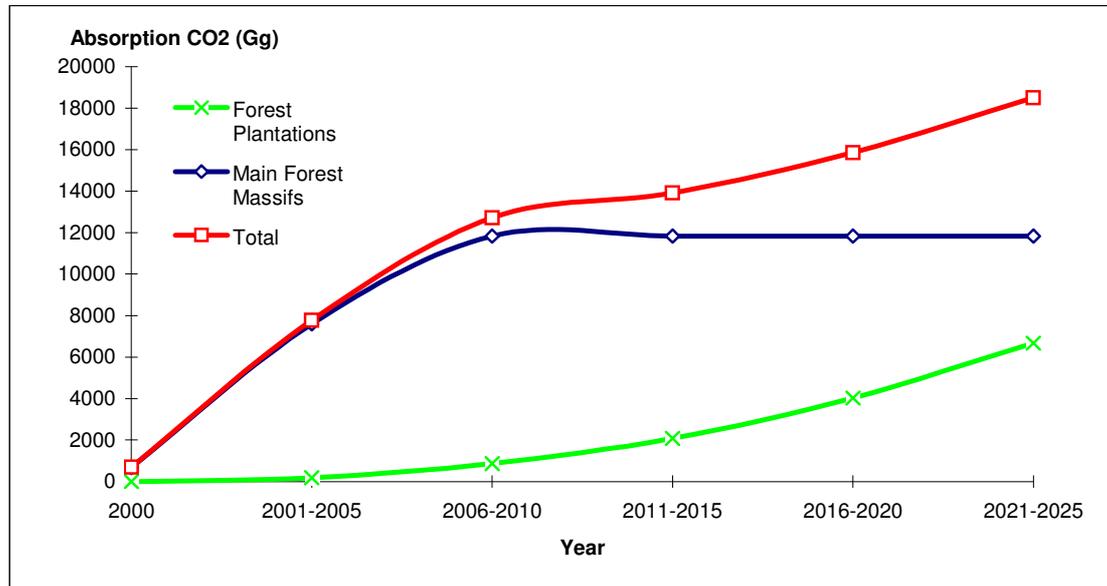
The probable forest development and forest restoration potential in Azerbaijan according to expert assessments will amount to 740 000 ha by 2025. When all these measures are implemented, the total carbon absorption from the wooded lands for 25 years will amount to 70 056 000 t, 20% of which will derive from new forest plantations and 80% from the existing forests. In comparison with the base year 1990, in 2025 the total CO₂ absorption from the wooded lands may increase by 2.1 times. It is pertinent to note that the potential land resources of Azerbaijan provide the opportunity to increase the total acreage of the forest plantations up to 1.5 million hectares.+

The low average increment and wood reserves in the national forest resource is related to the availability of a considerable acreage of low-density forests, thin areas, proliferation of low-value species, non-optimal soil and climatic conditions, and increased negative anthropogenic impact on forests. However, the climate productivity potential of Azerbaijan's forests is extremely high. The calculations have shown that the magnitude of the climatic index of potential productivity of the Republic's forests when all of the climate change scenarios are implemented may increase from 23% up to 53%.

Table 1. Execution of Forest Measures until 2025

Indicator	Period					
	2000	2001–2005	2006–2010	2011–2015	2016–2020	2021–2025
Forest plantations ('000 ha)	2.09	29.66	81.07	150.36	216.34	260.17
CO ₂ absorption ('000 tonne)	7	174	875	2 080	4 027	6 670
Total expense (million USD)	0.93	18.18	56.13	115.69	180.12	248.91
CO ₂ absorption expenses (USD/tonne CO ₂)	133	104	64	56	45	37

Figure 3. Forecast absorption of CO₂ based on proposed forest management measures.



Vulnerability assessment: forest system self regulation during climate change

When assessing the vulnerability of forests to climate change, we established that noticeable changes will take place in the forests' climatic borders, which may cause even more pronounced degradation of the forest zone. The greatest changes will take place under the GISS and GFDL-3 scenarios, when the upper tree line in the Greater and Small Caucasus may move upwards by 550–950 m, while in Talysh, in contrast, it may descend by 100–200 m. The lower forest margin may move upwards, depending on the forest location, by 50–200 m. While taking into consideration the modern anthropogenic load on the upper and lower forest borders, we made the assumption that the forest border will not change significantly overall.

Certain changes will take place in species content and forest productivity. Oak and hornbeam will remain in the piedmont area. In the upper part of the mid-mountain zone, beech forests will remain, with a mix of oak and hornbeam. We can expect that the acreage of valuable oak and beech forests will diminish; the acreage of hornbeam forests will increase. Across the country, especially in the piedmont zone, the proportion of drought-resistant tree and shrub species will increase. The replacement of oak and beech by hornbeam and other species began several decades ago. Thus, according to 1953–1988 data for certain forest management stations, the oak and beech forest decreased by 7 to 53%. However, anthropogenic factors are the reason for such species change, as it was these tree species that were used for fuelwood. However, as a result of forest restoration activities, nationally the area covered by non-state forests increased by approximately 70 000 ha, while the state forests increased by more than 90 000 ha.

The current forests of the state forest fund of Azerbaijan comprise 87.8% hardwood tree species, 2.2% softwood species, 1.6% acerose, 6.2% other tree types and 2.2% bushes. If the anticipated climate warming occurs as under the GISS and GDFL-3 scenarios, we can presume that the acreage of the hardwood tree species will decrease by approximately 2–2.5%, with oak species decreasing by 3–3.5% and beech by ca 15%, while hornbeams could increase by ca 19%. Thus, the total acreage of hardwood species may decrease by approximately 17 000 ha. Softwood species could be expected to decrease by about 4 000 ha (ca 20%). The acreage of other tree species may increase by 12–12.5% and bushes by 70%, equal to 13 000–14 000 ha.

Table 2. Carbon deposit changes

Tree species	Total acreage (‘000 hectares)	Carbon reserves (‘000 tons)	Yearly Increase (‘000 tons)
Hard-leaf species	-17.3	-956.3	-11.2
Soft-leaf species	-3.8	-111.7	-2.2
Other species and bushes	13.5	208.6	3.1
Total	-7.6	-859.4	-10.3

Thus, because of species compositional change on 13 500 ha and the decrease of the forest acreage by 7 600 ha, the total carbon reserves will decrease relative to the base level by 859 400 t, and the yearly increment in deposited carbon will decrease by 10 300 t (ca 2%). This magnitude is insignificant and lies within the possible calculation error margin, reflecting ambiguities in the source material. The results obtained confirm our thought that the upcoming climate changes will not have significant influence on the current borders, content and productivity of the forests.

Forestry adaptation strategy to climate change

The low average increment in the national wood reserves is related to the presence of a considerable acreage of low-density forests, thin areas, proliferation of low-value species, non-optimal soil and climatic conditions, and increased negative anthropogenic impact. However, the climatic productivity potential of Azerbaijan’s forests is extremely high. Calculations show that the magnitude of the climatic index of potential productivity of the Republic’s forests when all of the climate change scenarios are implemented may increase from 23% up to 53%. The implementation of forest stabilization measures will attenuate the climate change consequences through:

- observance of the forest protection legislative acts;
- assistance to natural restoration;
- bans on cattle grazing;
- fight against parasites and diseases;
- introduction of highly productive forest tree species; and
- increased forest acreage.

Taking into consideration the exclusive environment-forming and the nature protective functions of the forests, the adaptation strategy for the forest sector to the upcoming climate changes should be directed at forest restoration. Preliminary calculations with due consideration for different economic sectoral interests (primarily the agricultural sector) show that the optimal forest coverage of Azerbaijan equals 18–20%. There is potential for increases up to 5–7% in the Kuro-Arazsky lowlands; 20–25% in the piedmont part of the Greater and Small Caucasus; and 35–40% in the mountain forest zones. The acreage of the forest fund that is not covered by forest could serve as a reserve for future forest expansion, in particular those lands that are unfit or marginal for agriculture, as well as those lands subject to re-cultivation. There is a significant reserve for forest restoration in old forest harvesting sites, since covered by low-value tree and bush species, glades, rough pastures and burnt-over areas. Two factors that need to be considered when executing forest restoration activities are obtaining an optimum balance between the economic sectors, while increasing forest productivity.

The first task may be solved by using areas for forest plantations that are of little or no use to other economic sectors. The second task may be achieved by the selection of highly productive tree species, capable of adapting to the upcoming climate changes, by improving the structure and the productivity of the existing forest. For these purposes the most suitable tree and shrub species should be selected for forest restoration measures.

For mountain conditions in Azerbaijan, the species with best potential are oaks, eastern beech, hornbeam, hackberry (*Celtis* spp.), birch, pine and others. In the steppe zone, preference should be given to Araz oak, Eldar pine, turpentine tree, ailanthus, Chinese elm and other drought-resistant species. The best companion tree species for the mountain conditions include maple, great maple, Caucasian linden, common ash, alycha, cherry and cobnut. For the steppe region, species include the Araz maple, Japanese pagoda tree, English field maple, hawthorn and mulberry.

For cover loss on the mountain slopes and sandy land, protective plantations of several shrub species have considerable potential: locust, black locust, squawbush, European elder, rosehips and oriental hornbeam. When using plants to fix sands, it is expedient to use the Baku calligonum, narrow-leaf oleaster, Eldar pine, smoke-tree, fig, *Tamarix* spp., astragal, pomegranate, Persian bindweed and melur. The most stable and effective species for salinized soils are locust, black locust, mulberry, *Tamarix* spp. and pomegranate.

In order to achieve the set objectives by 2020, the forests should be restored to the extent of 200 000 ha. Low-value plantations should be replanted to the extent of 190 000 ha. More than 100 000 ha of the low-density forests could contribute to natural restoration by planting into the forest bed plantlets of valuable tree species, so as to systematically upgrade those areas to the category of high-density forests and increase forest productivity 2 to 3 times. In order to protect agricultural lands from water and wind erosion, and plantations from droughts and dry hot winds, it will be necessary to create about 16 000 ha of protective forest bands, increasing this acreage in the future by 9 000–10 000 ha.

The Main Forestry Adaptation Strategy to Climate Change comprises:

- Legislative initiatives and institutional changes (Forest Code; National Forest Programme).
- Improved forestry management (performing forest inventory, prospective forest station development plans, including climate change monitoring, database development).
- Increased forest activity efficiency through realistic work planning, regulation of livestock grazing, and mitigating anthropogenic stress.
- Increased human resources potential in the industry through training manuals that take into consideration the specific national forestry characteristics, and improved personnel qualification.
- Development of applied scientific studies requested by the production sector (targeted scientific programmes, use of the accumulated knowledge, linkages between science and production).

Review of future tasks and research topics, and lack of knowledge applicable to the international activity threats

Where activities remain at the “business as usual” level, we can expect several threats to the development of forestry in the country in the foreseeable future. These threats include:

- A lack of objective and comprehensive information on the condition of the forests on the national territory will prevent scientific planning of the development of the forestry sector.
- Worsening of the survival ability and general condition of existing plantations due to traditional reasons (lack of materials and financial resources, use of primitive technologies, unregulated livestock grazing, unauthorized forest harvesting, materials, parasites, diseases, etc.), as well as the new and increasing negative climate change impact.
- Change in forest growing conditions on the mountain territories under the influence of changing climate will result in shifts in the area of existing forest formations; in other words, the border between tree and shrub species will move upwards, with various consequences, including the loss of biodiversity.

- A decrease in the acreage of forest cover, degradation of the tree species mixture, decreased reserves and forest productivity, and deterioration in the age content of forests due to the combination of traditional threats and global warming.

Climate Change Projects in forestry

Fostering Community Forest Policy and Practice in Mountain Regions of the Caucasus

See: www.rec-caucasus.org/recc/index.php?f=12&su=12060010012&t=index

- The overall objective of proposed action is fostering community forest policy and practice in mountain regions of the Caucasus to address deforestation and climate change issues, secured land tenure and forest rights, rural poverty reduction, diminishing regional and national tensions and the risks of insurrections let by alienated elements, conservation and sustainable development needs of local communities.
- The project's specific objective is to respond to current demands of the countries in 1) elaboration of relevant to institutional, legal and technical set-up for community forest management, 2) awareness raising and capacity building of local communities and local authorities on sustainable forest management and 3) demonstration of best approaches/methods of immediate reforestation and landscape restoration in areas affected by land-slides, mudflows, avalanches and other natural disasters preventing measures.

The project was supported by EU funds.

World Bank – Country environment protection project

- Project objective: Creation of the “Shardag” National Park; preservation of the biodiversity between the greater and smaller Caucasus; and the expansion of the existing “Ordubad” National Park.

Bank KfW – The creation of the “Samur Yalama” National Park

- Project execution timeframe: 2008–2010
- Project objectives: Climate change contribution in the southern Caucasus; forest restoration activities on 350 ha, for which the project execution timeframe is one year.

World Wildlife Fund (WWF) Leopard protection in the Caucasus ecological region

- Project execution timeframe: 2009-2010

Asian Development Bank – Anti-mud slide measures in the Kishsky gorge of the Shekinsky region

- Forest restoration activities on 550 ha.

Review of the conditions and the work of the national research institutes in their studies evaluating climate change in the forest sector

Azerbaijan one research institution performing forest management research, namely the Republic Scientific Research Institute of Forestry. The institute made a study of "What impact do forest plantations have on the climate change?" but there was no theme directly related to climate change impact on forestry.

Summary list of issues for international cooperation, as proposed by consultants

- Supporting FAO in the study of positive world experience on:
 - Forest ecosystems vulnerability assessment. For the forest ecosystems vulnerability assessment of Azerbaijan's forests, an original procedure was used that has both strong and weak spots. The study of other vulnerability assessment methods will allow us to adopt useful experience and improve the forest ecosystems vulnerability assessment quality.

- Practical forestry adaptation measures to climate change in similar natural and climatic conditions, taking climate changes into consideration in prospective plans for forestry development. Studying world experience in planning and executing a set of practical climate change adaptation measures.
 - Preparation of a lecture course for educational institutions and organizations, aimed at qualification improvement on the issue of the climate change impact on forestry through adaptation. Studying other country experiences in educational institutions and with qualification improvement courses where climate change impact on forest ecosystems and adaptation measures to such changes have been studied.
- The execution of a small demonstrational CDM project on forestry.
 - The reorganization of forest management and forest statistics. At the present time, because of the unsatisfactory condition of the forest management service, forest statistics do not have sufficient credibility. To be well grounded, any decisions or calculations on forestry should be based on real statistical data. This applies also the statistical data required for GHG absorption inventory in the forestry sector.
 - The execution of a demonstration pilot project on pasture turnover in the mountain and desert zones. On the territory of the State forest fund, including wooded lands, livestock overgrazing is observed everywhere. This factor can be considered as one of the most important ones, influencing degradation of the forest ecosystems. This is why the creation of sustainable model of the forest fund use in the mountainous and desert zones for pastures is a task of current concern.
 - Knowledge dissemination on climate change impact on forestry among both experts and the general population.

References

- Alkiev, G.A. & Khalilov, M.Y. No date. Prikurinsky tugai forests of Azerbaijan.
- Amirov, F. 1997. The forests and forestry of the Azerbaijan Republic. Baku.
- Framework Climate Change Convention of the United Nations (UNFCCC), 1992.
- Greenhouse gases inventory workbook. The revised guideline principles of the national greenhouse gases inventory. MGEIK, 1996, Vol. 2.
- Initial National Communication of the Azerbaijan Republic under the Framework Climate Change Convention of the UN. Baku, 2000. 88 p.
- The forest fund inventory of the Azerbaijan SSR, Baku, 1983.
- The Initial National Communication on Climate Change of UNFCCC Research on the evaluation of impact and vulnerabilities of the Azerbaijan Republic to climate change. Baku, 1999.
- The Kyoto Protocol, UNFCCC, 1997.

BOSNIA AND HERZEGOVINA

Sead Vojnikovic

Summary of climate change dimensions

Although Bosnia and Herzegovina ratified the United Nations Framework Convention on Climate Change (UNFCCC) in 2000, and its Kyoto Protocol in 2008, research activities and capacity building have not developed sufficiently, as policy on and scientific research into climate change in Bosnia and Herzegovina have been affected by the post-war situation, with a very complex state administration; lack of state and regional level legislation; absence of national, international and inter-sectoral cooperation; etc.

Bosnia and Herzegovina has lacked studies addressing climate changing problems and their regional and local influences on forestry, forest productivity, biodiversity, etc. No models have been developed that could be used for assessing impact on forestry or for evaluating possible national areal changes to plant and animal communities.

The most complete report regarding climate change is the Initial National Communication (INC) of Bosnia and Herzegovina to UNFCCC. The majority of this text derives from that report.

Forestry

Forests represent one of the major natural resources of the country. Due to their natural and diverse structure, as well as extensive natural regeneration, they represent crucial resources for the further development of Bosnia and Herzegovina. The country itself is geographically optimally positioned in terms of diverse climatic influences (Mediterranean, sub-Mediterranean and middle continental climate zones) and is home to over one hundred tree species. The main species found are fir, spruce, Scots and European pine, beech, different species of oak, and less significant numbers of noble broadleaves, including maples, elms, ash, together with fruit trees (cherry, apple, pear).

Professional development and management in the forestry sector have focused on traditional systems, and has recently (especially following the turbulent post-war period, where forests have been neglected and abused) faced greater demands in terms of contributing more to protecting and enhancing all important forest functions, ranging from economic viability, to social responsibility and environmental and ecological sustainability.

Forests and forest land in Bosnia and Herzegovina encompass an area of approximately 5 073 000 ha (according to data from FAO, 2005; see: www.fao.org/forestry/country/32185/en/bih/), which is around 53% of the total land area. 2 186 300 ha (81%) is under state ownership, while 523 500 ha (19%) is in private ownership.

Available institutional and expert potential related to climate change and forests and forestry

The Constitution of Bosnia and Herzegovina is an integral part of the Dayton Peace agreement and has created a specific State comprising two entities, the Federation of Bosnia and Herzegovina and the Republic of Srpska. Under this constitutional construction, Bosnia and Herzegovina is a sovereign state with a decentralized political and administrative structure. In addition, a separate District, Brcko, was established within Bosnia and Herzegovina's borders.

Since the Dayton Peace Agreement, environmental issues in Bosnia and Herzegovina have been under the responsibility of entity governments. The competent authorities are the Federal Ministry for Tourism and Environment in the Federation Bosnia and Herzegovina; Ministry for Physical

Planning, Civil Engineering and Ecology in the Republic of Srpska; and Department for Communal Works in the Government of Brcko District.

The Government of Bosnia and Herzegovina is a party to a number of international environmental agreements and conventions, and is fully committed to meeting the requirements stipulated in these agreements. The most important institutions in Bosnia and Herzegovina related to climate protection and participation of Bosnia and Herzegovina as a Non-Annex I Party in the UNFCCC negotiation process were:

- Bosnia and Herzegovina's National Focal Point to the UNFCCC is the Ministry of Physical Planning, Civil Engineering and Ecology of the Republic of Srpska.
- Bosnia and Herzegovina's Committee for Climate Changes and Sub-Committees for Climate Change.
- GEF Political and Operational "Focal Point" for climate change.
- Administrative Committee for Sustainable Development.

The Kyoto Protocol was ratified in 2007. In accordance with the law on meteorological and hydrological activities of Republic of Srpska, the Republic Hydrometeorological Institute of the Republic of Srpska, as the governmental organization, is responsible, *inter alia*, for climate change monitoring, climate data exchange and database management, application studies and climate predictions in the framework of the various scientific and technical programmes of the World Meteorological Organization.

The Bosnia and Herzegovina Federal Institute for Meteorology, as an independent institution, is responsible for administrative and professional tasks related to meteorology; climatology; seismology; and hydrology and water resources; as well as for monitoring of environmental quality, including air; water; soil; collection, processing and publishing of data related to above mentioned activities, etc. Institutions that have a scientific role in and personnel for potential analysis of climate change related to forests and forestry are:

- Faculty of Forestry, University of Sarajevo
- Faculty of Forestry and the University of Banja Luka

Institutions that can also analyse the impact of climate change on forest ecosystems (without technical, technological or economic evaluation) are:

- Faculty of Science University of Sarajevo
- Faculty of Science University of Banja Luka

Direct climate change impact on biodiversity and ecosystems

Globally, climate change impact on biodiversity is well known and many studies have been published on the topic. However, few studies of climate change influences on agriculture and forestry in Bosnia and Herzegovina have been published. As far as the author of this text is aware, no studies have been conducted nationally that deal directly with the impact of climate change on biodiversity. The sensitivity and adaptation in the biodiversity protection strategy in Bosnia and Herzegovina reflects climate change and its possible influence on some landscape systems in Bosnia and Herzegovina. Therefore, there are no concrete examples for some species, and no models of change in areas have been created for specific ecosystems, nor for plant or animal communities. Based on existing research and available literature, this report evaluates climate change and its possible influence on agro-ecosystems in Bosnia and Herzegovina.

Considering a fast socio-economic development scenario, with balanced usage of energy sources and application of the latest technology in all sectors, versus extreme consumption of energy, with significant differences in projections of future emission of GHGs, in the region of southeast Europe, which includes Bosnia and Herzegovina, by the end of 21st century one can expect an

increase of mean annual air temperature of about 3.5°C compared with the annual average temperature in the last decade of the 20th century. Temperature increases like that would be accompanied by rainfall reduction of 12% annually, with the most reduction during spring and summer, to the extent of 16–24%. Beside these regional climate changes caused by global climate change, significant changes could be expected on a local basis. In that context, applying a scenario of partial application of measures for reduction in GHG emissions on the territory of Bosnia and Herzegovina implies an increase in air temperature of 3–4°C on average by the end of the 21st century. With those thermal conditions, in next few decades one could expect significant reduction in days with snow together with reduced rainfall in the warm half of the year, which would result in reduction of soil humidity and availability of water resources. The reduction in summer rainfall in Bosnia and Herzegovina would be 20% by the end of the century, and using climate models for the worst-case scenario (business-as-usual in level of GHG emissions), the increase in air temperature would be even bigger and the rainfall deficit could reach 40% during the summer. Based on the analysis by Predic (2001) of the frequency and extent of dry periods for the climatology station at Banja Luka for two periods (1962–72 and 1992–2000), which had similar annual precipitation. The work compared soils with a capacity of 50 mm (shallow land) and 100 mm (deep land). Results show that in the period 1962–1970, drought appeared three times, while 1992–2000 it was five times. It is alarming that in 1998, 1999 and 2000 drought appeared every year. Such drought periods are very significant for shallow lands with a water-holding capacity of only 50 mm, which are mostly sandy soils and typical of the area of Bosnian Posavina.

Climate change impact on ecosystem services

The areas of Bosnia and Herzegovina most sensitive to global climate change are defined in the strategy for the protection of biodiversity, which includes an action plan. The areas sensitive to the pressure of changing climatic conditions are:

- High-mountain ecosystems (above 1600 m) (Bjelasnica, Maglic, Igman, Volujak, Snjeznica, Vlasica).
- Mountain ecosystems (from 900 to 1600 m above sea level) (Klekovaca, Vitorog, Jahorina, Romanija, Kozara).
- Sub-Mediterranean forests and scrub ecosystems (from 300 to 800 m) (Eastern and Western Herzegovina).
- Karst caves, basins and abyss ecosystems (Herzegovina region; the best known is Vjetrenica cave).
- Highland ecosystems (from 600 to 900 m above sea level) (central, eastern, northwest and southeast Bosnia).
- Ecosystems of the Peripannonian area (from 200 to 600 m above sea level) (Kozara, Prosara, Motajica, Trebovac, Majevisa).
- Pannonian ecosystems (below 200 m above sea level) (Bosnian Posavina – Lijevece polje, Semberija).

High-mountain and mountain ecosystems, based on research available and assumptions of global climate change in Bosnia and Herzegovina, are exposed to the greatest impact. In terms of forest ecosystems, the most endangered ones are the fir forests, which, taking into account temperature and humidity, have a very narrow ecological zone. In contrast, the beech forests have very broad ecological tolerance, and it is expected that they will become more prevalent in forests that currently are composed of a combination of beech and fir. Ecosystems of sub-Mediterranean forests and scrub, and of karst caves and basins, as a result of global climate change, are expected to be affected by increased soil acidity. Peripannonian and hilly ecosystems are the second most in danger after high-mountain and mountain ecosystems. If we take into account the forecast temperature changes, most pressure would be on the oak forests, both cork oak and English oak. The sessile oak forests are the lowest forests in Bosnia and Herzegovina, and their altitudinal range is from 280 to 860 m (altitude amplitude is very low, at 580 m). Migration of the sessile

oak and English oak to areas of higher altitude is disabled due to their heavy seed. In addition, any increase in temperature is accompanied by an increase in dryness, resulting in slower decay of forest litter. As a result, a layer of raw humus would be formed, leading to the process of subsolation in the soil, and a significant decrease in biodiversity in lower vegetation layers.

A key problem of any impact of climate change on biodiversity and ecosystems in Bosnia and Herzegovina is the slow rate of adaptation of forest ecosystems in comparison with the rate of climate change, which happens very quickly. Defining protection measures for forest ecosystems requires more advanced research into impacts of regional climate changes on the forests, and an analysis of the socio-economic potentials leading to forest degradation.

In Bosnia and Herzegovina, the following main effects of climate change on biodiversity can be expected:

- Shift of vegetation zones (layers) in a horizontal and vertical direction.
- Shift and changes in areas of individual taxa of flora and fauna.
- Extinction of individual species.
- Changes in the quality and quantity composition of biocenoses.
- Fragmentation of habitats.
- Changes in functioning of ecosystems.

At present, no published studies are available that show the situation in the economically important tree species in relation to climate change. So, in the territory of Bosnia and Herzegovina, one cannot confirm exactly what change are likely in terms of increment, yield, mortality, change in stocks, or appearance for economically important trees, such as beech, fir, spruce, black pine, scotch pine and sessile oak.

Research is currently under way on dendrochronological research on fir and spruce, which will show whether there is a tendency for change in growth correlated with specific climatic parameters. Also, a study is currently being written up involving institutions and researchers from the region (Croatia and Slovenia), addressing the impact of climate change on the distribution of individual tree species (including fir, spruce and sessile oak) in southeast Europe.

Vulnerability of forest ecosystems to climate change

Due to their natural and diverse structure, as well as extensive natural regeneration, forests in Bosnia and Herzegovina represent one of its crucial natural resources. Its diverse soils and climatic influences support over one hundred tree species.

Most of the country is characterized by hot summers and cold and snowy winters. Short and cool summers and long, severe winters are common at higher elevations. The average temperature in January is -1°C , and in July it is 20°C . Along the coastline, temperatures are warmer and in winter there is more rain. Due to the extensive presence of forests in Bosnia and Herzegovina and the variety of climatic conditions to which they are subject, they have major roles in the context of climate change, and are sensitive to its effects. Currently they contribute to global carbon emissions when cleared, overused or degraded; when managed sustainably, they produce fuelwood as an alternative to fossil fuels and they absorb and store carbon in their biomass, soils and products. In the region of Bosnia and Herzegovina projections indicate a rise in temperature of $2\text{--}3^{\circ}\text{C}$ above the current average, with reduction in precipitation of $5\text{--}15\%$, especially in the warm seasons, which would contribute to reducing soil moisture from 15 to 25% . In addition to these changes in precipitation and temperature regimes, studies show the possibility of increased frequency of climatic extremes, such as storms, hailstorms, thunderstorms, destructive high winds, floods, long droughts, heat waves, and extreme high and low temperatures. Reduced snow cover is expected, as well as shifts of climatic zones towards higher altitudes, which influence

forest fire, erosion and other factors that might affect the forest ecosystems. All of these aspects can greatly influence the further development of forests in the country. Forest ecosystems in Bosnia and Herzegovina will be increasingly vulnerable to:

- temperature and precipitation changes;
- increased atmospheric concentrations of carbon dioxide (changes in tree growth and water use);
- altered fire regimes; and
- changes in the range and severity of pest outbreaks.

There is a possibility that climate change can influence the forests in Bosnia and Herzegovina in such ways that it may potentially over time transform entire forest systems, shifting forest distribution and composition.

It has been proven that increased atmospheric carbon dioxide concentrations can have an effect on individual tree productivity, but can also alter leaf chemical composition, affecting herbivore fitness as a result (Saxe, Ellsworth and Heath, 1998). Severe temperatures and climate conditions such as frost and heat stress, as well as changes in the form, timing and amount of precipitation (e.g. snow versus rain, drought versus flood) can affect individual trees, the stand and forest system because as it can lead to greater susceptibility to pests, pathogens and severe weather events. Another significant threat to forest ecosystems is caused by an increase in forest fires. It is estimated that 3000 ha of forest are lost to fires annually in Bosnia and Herzegovina. Increased risk of forest fires due to increased temperatures and changes in precipitation patterns is expected in some parts of Bosnia and Herzegovina, which calls for fire protection capacity to be expanded. All these aspects (weather, pests, pathogens, fire) can in the long term lead to lower productivity and undermine the health status of the forests in Bosnia and Herzegovina.

The fir forests within Bosnia and Herzegovina forests have the potential to be severely affected by climate change as they occupy a very narrow ecological niche. Due to their growth in mixed stands with beech, which has a broader niche, the beech trees have the potential to crowd out the fir within stands due to changes in humidity and temperature. Species with narrow niches will probably face decline or loss and may in the case of Bosnia and Herzegovina start to move to the margins of their habitats, which shows a shift of vegetation due to climate change, therefore making other species more dominant, which was not the situation originally (this may reduce the economic value of these forests).

In terms of biodiversity within forest ecosystems, the changes in precipitation and water availability may have an effect on bird and animal communities by leading to concentration of population in specific areas and increasing their vulnerability to pathogens. Another issue in terms of biodiversity and protected forest areas is the issue of protected areas. Bosnia and Herzegovina has only a very small area protected under IUCN categorization (less than 1% of the territory), which is an extremely small area in terms of regional averages and the natural potential of the country. Due to climate change effects, there is the possibility that in the future the already very small areas that are protected in Bosnia and Herzegovina might cease to protect the targeted species, features and processes. This calls for a reassessment of possible new areas and an extension of the size of the existing areas, including the consideration of forest ecosystem factors of high conservation value.

Sub-Mediterranean forests of Bosnia and Herzegovina are threatened by changes in soil chemistry and structure, with decreased pH levels and increased soil acidity, which will not be acceptable for the current species. The greatest threat will be to the oak species, which mostly grow at low altitudes (less than 860 m). The threats can undoubtedly cause species migration.

Status of assessment and research on climate change

A. Selmanagic has recently defended a Master thesis in the Faculty of Forestry, University of Sarajevo, "Advocacy coalitions as agents of change in climate change policy making – a case study of Bosnia and Herzegovina" (Selmanagic, 2009). The author has identified problems and main issues of climate change as:

- Who advocates changes initiates processes in the climate change policy-making domain of Bosnia and Herzegovina?
- Has there been significant national progress noted in terms of mutual cooperation and establishment of advocacy coalition networks among different groups in order to campaign for change, and what are the strengths of these coalitions?

This study has shown that the climate change policy-making arena in Bosnia and Herzegovina is fairly weak. The research has shown that the low level of interest of the governmental structures in this domain probably lies in the fact that low social mobilization exist around the issue and therefore the ruling parties do not have an interest in the facilitation of further developments in order to attract the voting populace. Another possible factor which might have contributed to the weak position of government institutions is the low level of staff capacity in climate change-related spheres, where administration is complex, priorities are multiple and areas for significant improvement are ample (institutionally and legally).

Bosnia and Herzegovina is a non-Annex I Party to UNFCCC and has no obligations to reduce its GHG emissions; nevertheless it has already experienced climate change consequences due to its vulnerability. The research framework within the climate change domain is very limited at the national level and there is almost no science–policy interface. Researcher have limited capacities with insufficient information flow, which further down the line leads to limited public awareness and maintenance of the status quo in many sectors. The media, as a dominant actor with its potential to spread information, knowledge and stimulate public reaction through diverse tactics, must be recognized as such within the coalition's agenda.

The current state of politics in Bosnia and Herzegovina, where the public continues to be silent and scientific contributions on the issue are lacking, leads to very little climate change-oriented activity. Thus, it comes as no surprise that climate change policy issues are not visible at every level of the policy-making agenda in Bosnia and Herzegovina.

Proposed areas for cooperation

Outcomes

Bosnia and Herzegovina as a country in development and post-conflict recovery has sufficient scientific and political capacity to monitor all events related to climate change occurring in the region and globally. FAO as an intergovernmental organization can and should have an impact on the situation regarding climate change in the field of forestry. Therefore, Bosnia and Herzegovina needs the support and assistance of FAO. This assistance could be reflected in the following:

- Increasing the area of protected forest areas (which are now a little around 1%) and setting up of permanent sampling plots in them to monitor climate change.
- Assisting in taking appropriate measurements for monitoring changes in the economic forests and applying protective measures to minimize the impact of climate change on forests. Activities would include monitoring impacts on forest productivity, biodiversity and plant and animal communities, together with developing models of the various impacts of climate change.
- Increasing scientific capacity for monitoring and analysing the status of climate change.

- Analysing the impact of climate change on forests in terms of monitoring socio-economic changes in the forestry sector and generally in society, and their consequences.
- Increasing interest in and capacity of state institutions to address the problem of climate change, and to this end the development of the state agency that will deal with this problem. Better cooperation is needed on this issue between the Federation of Bosnia and Herzegovina and the Republic of Srpska.
- Generally improving the flow of information about climate change at the international level and especially local science–policy relationships.
- Developing societal consciousness through active participation of the media and educational institutions in monitoring the problem of climate change at regional and local levels.
- Drawing attention to the effects of drought at lower elevations and changing groundwater levels threatening forest ecosystems.
- Addressing carbon balance problems, with special regard to soil (humus) conditions with warming, and to forest area changes, harvesting, afforestation and fires.
- Highlighting changes in the climatic environment and its impact on natural (protected) ecosystems and biodiversity as a special theme that has prime importance for Bosnia.
- Sensitizing and raising awareness in the media, in civil society and in political circles should have high priority.
- Create a baseline network for monitoring changes.
- Developing a programme and strategy of adaptation and mitigation in forestry practice, and identifying the necessary associated research tasks

References

- INC. 2009. Initial National Communication (INC) of BiH to UNFCCC, Banja Luka.
- Predic, T. et al. 2001. Impact of Climate Change on plant production in Republic of Srpska and in Federation of Bosnia and Herzegovina, Round Table: UNFCCC and Kyoto Protocol, Rights and obligations of Bosnia and Herzegovina as a member of the Convention. The Institute for Urbanism of Republic Srpska, Banja Luka.
- Saxe, H., Ellsworth, D.S. & Heath, J. 1998. Tree and forest functioning in an enriched CO₂ atmosphere. *New Phytologist*, 139: 395–436.
- Selmanagic, A. 2009. Advocacy coalition’s agents of change in climate change policy making – a case study of Bosnia and Herzegovina. Faculty of Forestry, University of Sarajevo.

GEORGIA

Paata Torchinava

Background

As a first step towards implementing its obligations under the Kyoto Protocol, Georgia prepared an Initial National Communication in 1997–1999. Since then a number of projects have been implemented in the country, aimed at studying various aspects of climate change and preparing for mitigation and adaptation proposals.

During 2006–2009, Georgia prepared its Second National Communication (SNC) to UNFCCC. In the process, the national GHG inventory was undertaken; future climate change scenarios have been developed; and the vulnerability of different ecosystems and economic sectors to current and expected climate change has been assessed. Adaptation projects were prepared, along with the planning of GHG abatement measures, and a number of activities in raising public awareness were conducted.

Based on the assessments and results obtained in the SNC, as well as other past and ongoing projects in Georgia, short- and long-term climate change strategies have been prepared. The strategies do not yet cover the whole territory of the country, but are focused on the priority regions selected during the stocktaking exercise. In terms of measures to facilitate adequate adaptation to climate change, the vulnerability of a priority area—*Kvemo Svaneti region*—has been assessed based on future climate change scenarios.

Summary of climate change dimensions

The national GHG inventory includes 6 sectors:

- Energy
- Industrial processes
- Solvents and other products use
- Agriculture
- Land Use, Land Use Change and Forestry
- Waste

Land Use, Land Use Change and Forestry (LULUCF)

In Georgia in 2000, 2085.5 Gg C were removed by sinks by the LULUCF sector, whilst emitting 412.1 Gg C, and amounting to a net absorption of 1673.4 Gg C. The carbon absorption by forests amounted to 1392.6 Gg C (66%), by other woody biomass 573.7 Gg C (27.5%), and by soils 119.2 Gg C (5.7%). The forests emitted 294.7 Gg C (31.5%), other woody biomass 49.2 Gg C (11.9%), and soils 68.2 Gg C (16.5%). Accordingly, the net uptake by forests made up 1097.9 Gg C (65.6%), other woody biomass 524.5 Gg C (31.3%), and by soils 51.0 Gg C (3%). The LULUCF inventory was based upon the idea that the flow of CO₂ from (or to) the atmosphere was equal to changes in carbon stocks existing in biomass or soils, and that the changes in carbon stocks could be assessed on the basis of land-use change and activities, causing these changes (burning, clear felling, selected cutting, etc.). In the IPCC approach, the emissions assessment examined changes in carbon stocks caused by changes in forest and other woody biomass stocks, forest and grassland conversion to agricultural or other types of land, carbon uptake by the abandoned (managed) lands, and emissions and removals from soil.

In Figure 1 the amount of absorbed and emitted carbon (Gg C) from this sector is given for 2000, and in Figure 2 the trend of net uptake (Gg C) is shown for 1990–2006.

Figure 1. Carbon emissions and uptake in Gg C for 2000.

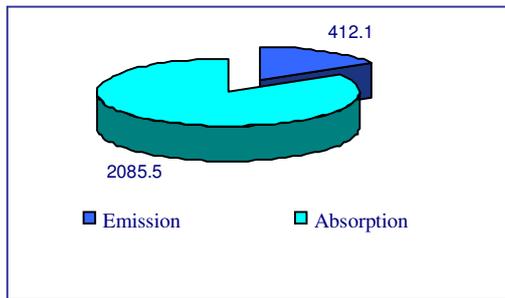
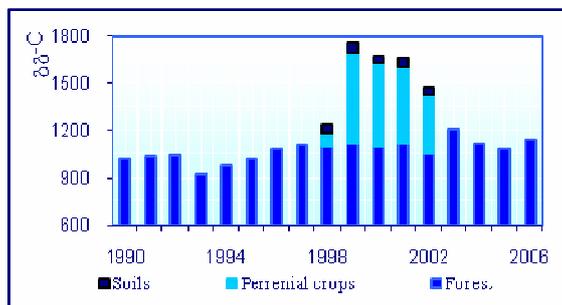


Figure 2. Trend of net carbon uptake in Gg C from the LULUCF sector.



Changes in forest and other woody biomass stocks

In forests, the continuous process of CO₂ absorption from the atmosphere and its emission in turn takes place subject to natural and anthropogenic causes. Emissions of CO₂ from changes in forests and other woody biomass stocks are caused by changes in carbon stocks as a result of an increase or decrease in biomass (e.g. commercial extraction of timber and traditional consumption of fuelwood). According to the IPCC classification, Georgia is situated in a temperate climate zone in which seasonal changes in climate are well pronounced.

The territory of Georgia's forest fund equals 2.9 million hectare, of which 2.7 million hectare is covered by forests, making up 40% of Georgia's total territory (6.97 million hectare). The state economic forest fund occupies 2.4 million hectares, of which 2.3 million hectares is covered by forests. The annual increment of timber amounts to 4.6–4.8 million m³, and the annual average increment of timber per hectare is 1.8 m³. Total wood reserves amount to 451.7 million m³.

The distribution of forests, which are massive across the national territory, is complex and full of contrasts. More than 90% of forests are situated on mountain slopes (the greater and smaller Caucasus Mountains). A significant part (40%) of them occupy very steep slopes (>35%), as a result of which the economic use of forests is very limited. Georgia is characterized by a variety of environmental conditions that promote the spread of different kinds of trees. Detailed data on the distribution of forests by kind of trees (vegetation) does not exist. Hence, they are classified only as coniferous or deciduous.

The total absorption of CO₂ by forests was assessed by multiplying the areas occupied by coniferous and deciduous forests by the IPCC 1996 default values of mean annual increment of biomass, and summarizing the results obtained. Calculations for 1998–2002 were made by applying the IPCC Tier 1 methodological approach, using default coefficients relevant to specific climatic zones in Georgia. For other years, the information was not available.

Calculations were performed for the areas occupied by forests having an economic function. Therefore, the data on areas covered by coniferous and deciduous forests were taken from Georgia's forest fund statistical yearbooks, compiled on the basis of inventories carried out in different years by the forestry department. As for stored timber and forest fire data, these were taken from the balance reports compiled at the end of each year for the forestry department.

In 2000, the annual increment of biomass in Georgia's forests amounted to 1392.6 Gg C, while as a result of commercial extraction and traditional consumption of fuelwood, 294.7 Gg C had been released (see Figure 3). Hence in 2000, the net absorption of carbon in Georgia's forests equalled 1097.9 Gg C, or 4025.5 Gg CO₂. Compared with 1990 (3738.8 Gg CO₂), in 2000 the net absorption of CO₂ had increased by 286.7 Gg CO₂. Figure 4 demonstrates the trend in carbon net absorption change in Georgia's forests for 1990–2006. Among other stocks of woody biomass, the areas covered by perennial crops (fruit orchards, tea plantation, etc.) were considered, for which the annual changes in carbon stock contained in green biomass were calculated.

In 2000, the net change in carbon stock contained in perennial green biomass crops amounted to -524.544 Gg C, or 1923.328 Gg CO₂ had been absorbed. Figure 5 shows the amounts of carbon absorbed and emitted by the perennial crops. In 2000, the net change in carbon stock in forests and other woody biomass in Georgia was 1640.4 Gg C, i.e. 6014.9 Gg CO₂ had been absorbed from the atmosphere. Figure 6 shows the amount of absorbed and emitted carbon from Georgia's forests and other woody biomass stock.

Figure 3. Carbon emission and absorption (Gg C) from Georgia's forests, 2000.

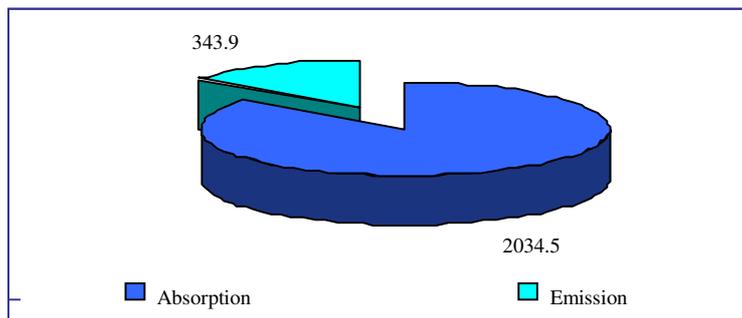


Figure 4. Trend of net carbon uptake by forests, 1990- 2006.

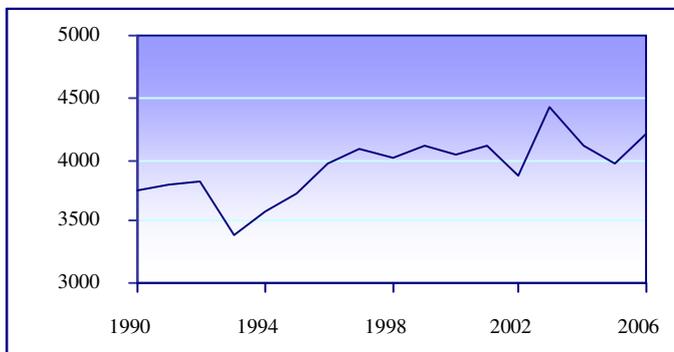


Figure 5. Carbon absorption and emission (Gg C) from perennial crops, 2000.

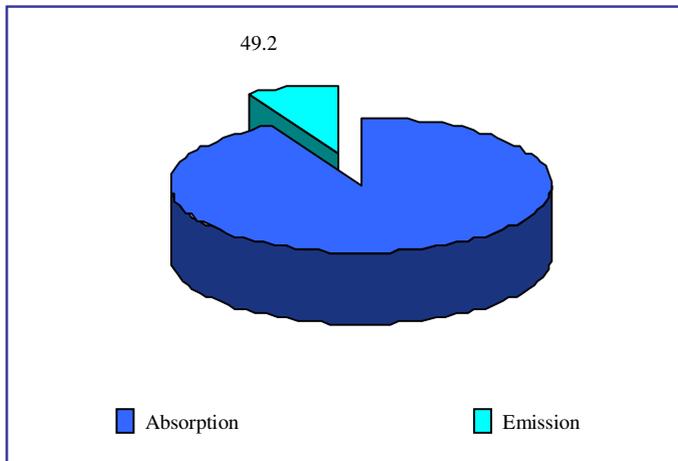
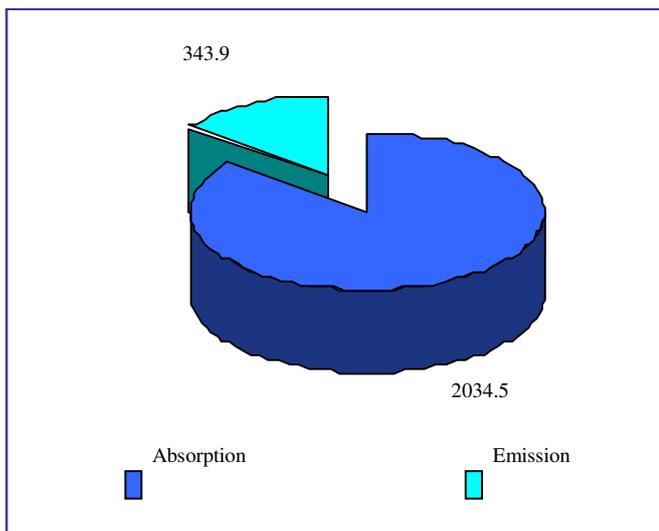


Figure 6. Carbon absorption and emission (Gg C) from forests and other woody biomass stocks, 2000.



Strategy for climate-change related actions

As was mentioned above, in 2006–2009, Georgia prepared its SNC to the UNFCCC. In the process of this activity a National GHG Inventory was undertaken, anticipated climate change scenarios were developed and the vulnerability of the different ecosystems and sectors of the economy to current and expected changes in climate was assessed. Adaptation projects were prepared, along with the planning of GHG abatement measures, and a number of activities in the field of public awareness were carried out.

This strategy on climate change was prepared on the basis of assessments and results obtained in the framework of the SNC and other active or completed projects implemented in Georgia. It does not yet cover the whole territory and is oriented predominantly towards the estimation of climate change impacts on the most vulnerable systems; possible extreme events (eroded soils,

floods and landslides); preparation of adaptation measures; and the implementation of already prepared adaptation steps.

Measures to facilitate adequate adaptation to climate change

The current change in climate elements in Georgia, and in priority regions (see below) in particular, has been assessed based on actual observation data. The Vasil Gulisashvili Forest Institute elaborated a proposal to study the potential of carbon in Georgian coniferous forest ecosystems. It should be stressed that environment protection is not yet a priority for the country, and therefore the integration of climate change issues in sectoral development programmes and concepts is almost impossible. There is also a lack of national expertise on climate change; an absence of relevant scientific assessments and surveys; a lack of coordination and information-sharing between relevant projects and programmes being implemented in the country; and poor awareness among decision-makers, the private sector and the general public. The country's capacity-building needs include re-training of local experts in cross-cutting issues, encouraging young experts in their involvement with international programmes, and improving the accessibility of national statistics.

Climate change mitigation policies and measures

The GHG inventory prepared within the SNC of Georgia for 2000–2006 demonstrated that the leading sector in GHG emission is the energy sector (including the transport subsector). That is why the main emphasis was placed on this sector in the planning of mitigation measures. However, this does not mean that other sectors, including solid waste, agriculture and forestry, were not considered in the mitigation strategy, but rather that their share (excluding forestry as a GHG sink) compared with the energy sector is insignificant in Georgia.

Status of work by national research institutions on research for assessment of climate change

Activities included theoretical and experimental studies and fieldwork. Scientific study has addressed both fundamental and applied activities. Results have led to various recommendations. In terms of scientific research, in the past 10 years since the preparation of the INC a number of research projects have been implemented by Georgian research institutions and scientific organizations. The research was mainly conducted at the Vasil Gulisashvili Forest Institute, Institutes of Hydrometeorology, Geography, Centre of Monitoring and Forecasting, and at I. Javakhishvili Tbilisi State University. The research has included addressing problems of survey of climate change in different regions in Georgia, and the recreational-climatic division by regions of the Georgian territory.

Table 1. Climate Change Strategy of Georgia. (This table only shows activities with a forestry component.)

Key strategic objective	Key target groups	Activities	Potential lead entity	Output
Assessment of vulnerability to climate change and adaptation				
Drawing of investments and facilitating the implementation of adaptation measures in Dedoplistskaro region. Financing of adaptation projects is already initiated	Local administration; Gov't of Georgia; Farmers; Protected territories; Local Administration	Permanent monitoring of adverse; impacts of climate change; Rehabilitation of wind-breakers; Establishing of energy forests; Rehabilitation of eroded soil; Mobilisation of farmers associations; Facilitation of proper management of pastures; Creation of efficient scheme of irrigation systems and their rehabilitation.	Local administration; Population.	Wind breaker are rehabilitated; Pilot energy groves are planned; Package of measures to rehabilitate the degraded lands is prepared; Farmers associations are created and mobilised; Proper management of pastures is introduced; Irrigation systems are rehabilitated primarily at the high risk sections.
Attraction of investments and promotion of the implementation of adaptation measures in Lentekhi region	Gov't of Georgia; Local administrations (Municipality); Population; NGOs.	Creation in the region of landslide Monitoring and Early Warning System; Creation of river floods Monitoring and Early Warning System; Establishment of population (households) awareness raising (informing) system and trainings on prevention measures; Implementation of pilot projects to avoid landslides (e.g. arrangement of small conformable plantations); Rehabilitation & proper management of most damaged forest areas; Restoration of landslides protection function of forest in places not affected earlier by landslides and planning of new plots; Accurate inventory of climate induced landslides and preparation of recommendation measures.	Local administrations; Population; NGOs.	Landslides monitoring service is established locally; Population in landslide endangered areas are constantly informed on potential risks and measures, that could be taken by themselves to avoid the danger; Pilot projects on planting hazelnut, as a soil fixing plant, are implemented; Rehabilitation/restoration of most damaged forest plots is systematically carried out;
Mitigation of GHG emissions				
Promoting maximum activation of CDM in Georgia	MoE; Ministry of Energy; Ministry of Finance; Private sector.	Selection of sectors providing maximum efficiency in programmatic and sectoral approach (wind, biomass, solar energy, energy efficiency in residential sector, waste, forests); Promoting private sector activation (especially banking sector) in CDM; Improvement of CDM promoting legislative basis.	MoE (DNA)	Projects prepared in the framework of CDM are implemented; New projects are prepared.
Studying the local capacity for development of biomass (energy forests and other biomass) sector Assessment of its role in providing Georgia's energy system independence. Determination of the possible share of biomass in heat supply to 2020-2025	MoE; Ministry of Energy; Cabinet of Minister; Local administrations; NGOs.	Attraction of investments to implement pilot project on biomass energy forest (Dedoplistskaro region); Preparation of new project proposals on effective utilization of biomass energy (including wood) in heat generation; Assessment of actual potential of this resource in Georgia.	MoE	Georgia's energy forest and other biomass potential are assessed; Biomass development strategy is worked out.

Key strategic objective	Key target groups	Activities	Potential lead entity	Output
		Public Awareness		
Education, training and raising public awareness	Public school and high school students; Teachers & lecturers; Professionals, managers, other stakeholders; Policy makers; Experts; Mass-media; Farmers; Businessmen; NGOs.	Integration of climate-change related topics into education programmes; Training of scientific, technical and managerial personnel to ensure the implementation of UNFCCC Article 6; Enhancement of participation of different target groups and stakeholders in climate-change related processes; Promotion and support the preparation and dissemination of information on climate change issues targeted to the public awareness (preparation, printing and dissemination); Enhancement of policy-makers awareness of the possible results of climate change.	MoE; Ministry of Education and Science; NGOs.	National roster of experts in all sectors is continuously updating; In schools and at the relevant faculties (Chemistry, Biology, Geography, Modelling, etc.) of universities the climate change phenomenon and its implications are studied; Policy makers are systematically informed of latest results.
Long-term strategy (after 2020).			MoE.	
Transfer of Georgia's economy to the sustainable development principles; Working out and implementation of the National Plan on the possible mitigation of GHGs.				

Table 2. National GHG Mitigation Strategy (2010-2025)

Key Strategic Objective	Key Target Groups	Activity	Potential Lead Agency	Output
<i>Short-term objectives</i>	Ministry of Energy; Energy Efficiency Centre; Industrial enterprises; Private sector dealing with renewable energy; Population.	GHG mitigation short-term strategy implies maximum promotion of renewable energy using the CDM potential. Energy saving measures are predominantly implemented by the population	Ministry of Environment Protection and Natural Resources; Ministry of Energy; Parliament of Georgia.	In case of active facilitation of the government and carrying out of targeted policy the consumption of energy and relevant emissions of GHGs should be reduced by 24% compared to the Business As Usual scenario, and power generation will be totally covered by renewable energy (hydro and wind)
Fuel switching in heat energy demand				
Increase the share of biomass fuel in heat supply sector	Rural population; Government of Georgia.	Adoption of legislation facilitating the increase of biomass share in heat (cooking) energy supply; Identification of the appropriate territories for planting new energy forests; Identification of potential energy forests amongst the existing ones & preparation of proposals for their rehabilitation & management; Rehabilitation of existing (natural) energy forests and improvement management component; Establishment of PPP (Public Private Partnership) in fuel-wood supply sector; Establishment of plantation forest estates using the abandoned, eroded lands (see proposal for 40 ha plantation of bio-energy forest); Piloting the pellet/briquette industry in Georgia.	Local government; Local NGOs; Ministry of Environment and Natural Resources; Parliament of Georgia Department of Forestry; Private sector.	Plantations of energy forests established in Dedoplistskaro region (pilot 40 ha); Local private sector/farmers organised PPP in fire-wood production and supply sector; Pellet/briquette plant installed in West Georgia (Zugdidi region); Local population supplied by biomass fuel particularly in the remote regions (far from forested areas or settled near the protected territories) and facing the energy crisis.
<i>Long-term strategy</i>	Ministry of Energy; Ministry of Environment Protection and Natural Resources; Ministry of Agriculture; Department of Transport; Municipalities of big cities	In the long-run (after 2025, and possibly earlier) one of the priorities should be the increase in biomass (bioenergy) production in forest-poor regions of Georgia, transport and heat-supply sectors should be more actively involved in mitigating GHG emissions. Country's economy in general is transferred to sustainable development principle	Ministry of Environment Protection and Natural Resources, Hydrometeorology and Climate Change Administration; Ministry of Energy; Ministry of Agriculture	

Status of assessment and research on climate change

As mentioned above, the vulnerability of a priority area, the Kvemo Svaneti region, has been assessed based on future climate change scenarios. According to a survey of the region, as well as after consideration of the Forestry Institute's proposal, tasks and research themes were identified appropriate for international cooperative activities with FAO and other UN Agencies.

Kvemo Svaneti region

In selecting the region most vulnerable to climate change on the territory of Georgia, attention has been focused on the Lentekhi region in view of the fact that it is typical of a mountain zone of West Georgia in terms of climatic and landscape features. Therefore, this region could be regarded as an indicator of the impact of climate-change-driven processes on natural ecosystems and the economy. At the same time, the existence of population and some sectors of the economy make it possible to plan and implement a number of adaptation measures in the region, which could serve as an example for implementing the same activities in Georgia's other mountain regions. The expected risks caused by climate change in the Lentekhi region can be summarized as:

- Increased phytopathological challenges can be expected in both crops and forests. These processes are being already observed.
- Population migration (rise in the number of eco-migrants).
- Further decline in the quality of forests.

Study of carbon potential in Georgian coniferous forest ecosystems

Special attention is paid to the conduct of applied activities. In terms of promotion of the implementation of UNFCCC by the Vasil Gulisashvili Forest Institute, a proposal was elaborated. The main objective would be to study the carbon potential of Georgian coniferous forest species (spruce, firs, pines) ecosystems, establishment of carbon balance and the forest's role in the global carbon cycle.

The novelty of the proposal is that for the first time in Georgia, the carbon stock in spruce, fir and pine forest ecosystems (above- and below-ground biomass and soil humus) will be studied. Deposited carbon and carbon emission will be determined in coniferous forest ecosystems in general, as well in different components by age classes. A result of project implementation will be determination of the role of Georgian coniferous forests in the global carbon cycle.

Proposed areas for cooperation

Table 3. Proposed activities to be implemented in the Kvemo Svaneti region.

Key Strategic Objective	Activity	Output
Short-term objectives (2009–2025)	The objective of the short-term strategy is the creation of landslide monitoring systems, preparation of preventive measures for the residents in landslide-endangered zones, improvement of forest management.	
Carrying out of rehabilitation and proper management of the most damaged parts of forests	Selection of the most damaged areas in local forests; Preparation of a strategy for the rehabilitation of damaged areas in forests and their proper management, as well as pilot projects; Attraction of local and foreign investments to implement pilot projects through technical assistance; Carrying out permanent monitoring on the selected areas.	Permanent monitoring undertaken on forest quality, especially in the damaged areas; Package of measures prepared to be implemented for the restoration of forest quality and improvement of management; Forestry projects prepared to be submitted to the CDM.
Restoration of the landslide preventive function of forest ecosystem; Planting of new plots	Selection of forest plots having landslide retaining function; Preparation of project proposals for the restoration of landslide retaining forests; Creation of monitoring systems at the selected sites; Provision of local population with fuelwood.	Forest plots having special landslide retaining function selected and project proposals prepared for the restoration of such forests; Permanent monitoring at landslide retaining sites organized; Public-Private Partnerships structure organized to supply population with fuelwood.
Preparation of a preventive measures package to protect local forests from the intrusion of pests.	Identification of forest areas damaged by pests; Preparation of packages of measures to rehabilitate damaged plots; Preparation of preventive measure packages to protect new plots; Implementation of rehabilitation measures at damaged plots.	Forest areas damaged by pests rehabilitated; Preventive measures against pests carried out permanently.
Long-term strategy (after 2025)	Preparation of adaptation measures in case of climate zones transformation; Study of snow avalanche hazards increase due to climate change (both regions of Svaneti); Study of historical monuments vulnerability to climate change (both regions of Svaneti).	

Activities proposed by the Forest Institute

Research Goal

Quantitative assessment of sequestered carbon stock in Georgian coniferous forests, and determination of parameters of carbon cycle.

Objectives of the research

- Determination of phytomass stock and composition of deposited carbon in coniferous forest ecosystems, segregated by species (spruce, fir, pine) and age classes (young growth (shoots), middle-aged, mature, over-aged).
- Knowledge of the quantity and distribution of CO₂ and the carbon balance.

- Evaluate the results of the recent intensive harvesting activities of a huge amount of commercial wood and fuelwood, including estimating the carbon released from such forest activities. In particular assess the possibility that the Georgian forest carbon balance has changed to being a net emitter of atmospheric carbon from a net absorber

Thus, there is a priority aim to determine if Georgian coniferous forests represent a positive or negative carbon balance, and provide recommendations to the Forestry Department on quotas for annual logging to avoid loss of the carbon regulation function of forest ecosystems; increase afforestation activities; restoration of fire sites using endemic species; and assist natural restoration on burnt-over areas.

References

- Amiranashvili, A., Bliazde, T. & Chikhladze, V. 2008. Assumed ecological consequences of forest fire in the natural reserve of Borjomi-Kharagauli during August 2008. *Transactions of the Georgian Institute of Hydrometeorology*, 115: 286–293.
- Beruchashvili, N.L. 1995. *Landscapes, models, experiments*. Tbilisi [in Russian].
- Burjanadze, M. & Supatashvili A. 2009. Relations between forest insects and pathogens and global climate change. *Forest News (International scientific-practical magazine)*, Vol. 2.
- Clarke, D. 1998. *CropWat for Windows: User Guide, Version 4.2.0013*.
- Climate Change, 1995. 1996. *The Science of Climate Change. The contribution of WG-1 to the Second Assessment Report*. Cambridge University Press/IPCC.
- Energy Balance of Georgia 2001. *Statistical Publication*, Tbilisi, 2002 [in Georgian].
- Energy Balance of Power Sector of Georgia. 2006. USAID, Advisory Assistance to the Ministry of Energy of Georgia. Tbilisi.
- Georgia's Initial National Communication under the UNFCCC. 1999. *National Climate Research Centre*, Tbilisi.
- Glossary on Agriculture Meteorology. *Gidrometeoizdat*, St. Petersburg, 2002 [in Russian].
- Greenhouse Gas Inventory Reference Manual. Revised 1996. *IPCC Guidelines for National Greenhouse Gas Inventories*. IPCC/OECD/IEA, Geneva.
- IPCC. 2000. *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*.
- Jones, R.G. et al. 2004. *Generating high resolution climate change scenarios using PRECIS*. Meteorological Office Hadley Centre, UK.
- Kordzakhia, M. 1961. *Climate of Georgia*. Tbilisi [in Georgian].
- Metreveli, G.S. et al. 2006. Global Warming – Present Climate Fluctuation and Current Eustasy. *World Resource Review*, 18(4).
- Nakicenovic, N. et al. 2000. *Special Report on Emissions Scenarios*. IPCC, Cambridge, UK.
- Shvangiradze, M. & Kutaladze, N. 2008. The anticipated climate change in Georgia. *Bulletin of SNC*, Result obtained in 2007. Tbilisi.
- Stockes, C.R., Gurney, S.D., Shahgedanova, M. & Popovnin, V. 2006. Late-20th-century changes in glacier extent in the Caucasus Mountains, Russia/Georgia. *Journal of Glaciology*, 52(176): 99–109.
- Svangiradze, M., Beritashvili, B. & Kutaladze, N. 2008. Revealed and predicted climate change in Georgia and its impact on economy and natural ecosystems. *Transactions of the Georgian Institute of Hydrometeorology*, 115: 76–80.

- Turmanidze, T. & Simonishvili, L. 2006. Ecological problems of Georgia's food security. Tbilisi [in Georgian].
- Vachnadze, G., Tsereteli, G., Nakaidze, E. & Torchinava P. 2009. Intension of CO2 emission from soil of fir stands. Vasil Gulisashvili Forest Institute Collection of scientific works. Volume 2(1): 46. Tbilisi, Georgia.
- Wigley, T.M.L., Raper, S.C.B., Smith, S. & Hulme M. 2000. The MAGICC/SCENGEN Climate Scenario Generator: Version 2.4. Technical Manual. Climatic Research Unit, UEA, Norwich, UK.
- Yates, D., Sieber, J., Purkey, D. & Huber-Lee, A. 2005. WEAP21 - A Demand-, Priority-, and Preference-Driven Water Planning Model, Part 2: Aiding Freshwater Ecosystem Service Evaluation. Watering International, 30(4): 487-500.

Annex 1. Institutions with climate change-related activities and their functions

Institutional structures directly related to climate change	Functions
Climate Change Administration at the Ministry of Environment Protection and Natural Resources	Coordination, direction and monitoring of policy and measures implemented.
National Environmental Agency at the Ministry of Environment Protection and Natural Resources	Preparation of legislative basis and proposals and their submission to the appropriate Committee of the Parliament.
Department of Forestry at the Ministry of Environment Protection and Natural Resources	Monitoring of measures planned.
	Monitoring of the documentation to be submitted to the UNFCCC.
Scientific organizations	Functions
National Academy of Sciences of Georgia	Data exchange, processing, scientific research and analysis.
Vasil Gulisashvili Forest Institute	
Scientific Research Institute of Hydrometeorology Institute of Geography Institute of Geophysics Institute of Botany	
I. Javakhishvili Tbilisi State University	

KAZAKHSTAN

Irina Yesserkepova

Concise report and summary of national publications on climate change dimensions and impacts

Initial climate change studies in Kazakhstan (1995–2000)

Climate change studies in Kazakhstan have been conducted regularly since 1995, following ratification of the UN Framework Convention on Climate Change (UNFCCC) by the Republic of Kazakhstan. The first climate change projects were implemented with the support of international programmes, including the US Country Studies Program (1995–1997) (US CSP) and the Netherlands Climate Change Studies Assistance Programme (1998–2000) (NCCSAP). For these projects, implementation groups were organized comprising specialists and scientists from various scientific research institutes and other organizations. The Kazakh Research Institute of Environmental Monitoring and Climate (now the Kazakh Ecology and Climate Research Institute, KazNIIIEK) was responsible for all activities in climate change studies. KazNIIIEK is a scientific subdivision of the Ministry of Environmental Protection of the Republic of Kazakhstan (MEP).

Research under the US CSP project had five central themes:

- climate dimensions and regional climate change scenarios;
- vulnerability and adaptation of natural resources and economic sectors to climate change impacts;
- GHG inventories in the Republic of Kazakhstan;
- climate change mitigation assessments; and
- national climate change action plan development.

In April 1997, the results of the US CSP project were discussed at a national climate change seminar coupled with an international conference. The project results were published in the journal *Hydrometeorology and Ecology*, No. 3, 1997, and other publications. They included articles on long-range climate changes and their consequences for grain productivity, climate global warming contribution to the development of desertification processes in Kazakhstan, assessment of climate change impact and adaptation of spring wheat, pastures, glaciers, geocryological conditions and mudflow-forming factors in the mountains of the country. A National Climate Change Action Plan (NCCAP) was developed in the second phase of the project. It was considered as part of the National Action Plan on Environment Protection of the Republic of Kazakhstan. Forests in Kazakhstan were considered a carbon sink and three categories of forest management activities were identified as potentially decreasing CO₂ emissions: management for conservation, management for storage, and management for substitutions. Possible mitigation measures considered for the forest sector in Kazakhstan, included:

- promoting improved logging practices to reduce the damage to residual trees and the soil;
- encouraging agroforestry activities to contribute to sustainable development;
- promoting forest expansion through tax policy to encourage forest management that reflects the long-term nature of forest investment;
- promoting an improved legal and policy framework to control deforestation, encourage development and climate change mitigation, including technical exchange programmes on environmental impact assessment and mitigation, and improved environmental planning;
- encouraging the use of long-lived forest products;
- providing financial incentives for new afforestation activities on private lands; and
- controlling air pollution effects on forests.

A list of climate change adaptation and mitigation measures in the forest sector were included in the National Climate Change Action Plan as priority actions. However, it was not possible to implement the action plan at that time because of a lack of financing.

During the Kazakhstan-Netherlands project *Climate Change Studies in Kazakhstan* under the NCCSAP support there were three research subprojects implemented which covering the gaps of the previous climate change studies. The First National Communication of the Republic of Kazakhstan summarized past studies, which were compiled and published. The second subproject related to GHG inventory emissions for 1994 and 1990. The third subproject was an assessment of impact and adaptation to climate changes for Kazakhstan's part of the Caspian Sea coastal zone, and the southeastern mountain regions of the country, with a focus on strategies for prevention of snow avalanches and mudflows.

Climate change studies in Kazakhstan are very important because its natural resources and economy are significantly vulnerable to climatic changes due to limited water resources, a large territory and peculiarities deriving from its geographical location at the centre the huge Eurasian continent. The sectors and regions in Kazakhstan most vulnerable to climate change were identified as water resources, agriculture (wheat production), grasslands, mountain ecosystems, and the Caspian Sea coastal zone. The main scientific results from these studies are that:

- the mountain areas of the south and southeast of Kazakhstan are vulnerable to climate change impact;
- the frequency and intensity of debris flows and snow avalanches can be expected to increase as a result of potential climate change;
- the expected rise in level of the Caspian Sea, in combination with storm surges, will cause high sea water levels;
- the Caspian Sea level rise will cause an elevation in groundwater level in the coastal zone; and
- the estimated economic and social damage caused by climate change in these areas is significant.

The contribution of the project conducted under the NCCSAP to the national climate change policy in Kazakhstan is important. The FNC was distributed among the key Ministries and other interested organizations, with a summary for policy-makers on climate change impacts and adaptation assessments, with enhanced public awareness and concern about climate change. The increase of public awareness fostered policy decisions on institutional strengthening on climate change. That is why the study on climate change adaptation strategies for mountain regions was continued under a one-year project on "Mudflows, snow avalanches and climate change in Kazakhstan" (2002). This project was supported by the Swiss Federal Institute for Forest, Snow and Landscape Research (WSL) and the Swiss Federal Institute for Snow and Avalanche Research (SLF). As a result, a system of snow avalanche forecasting at Zailiyskiy Alatau range was developed based on Swiss experience and introduced into the Kazhydromet warning system.

Climate change studies in Kazakhstan from 2000 to date

Since 2000, activities on climate change have been implemented at the request of MEP within the Programme on scientific research in the area of environment protection, and the UNDP/GEF project "Enabling activities for the preparation of Kazakhstan's Second National Communication to the UN Framework Convention on Climate Change" (2006–2008). Climate change studies are very important in Kazakhstan and have been continued for MEP within the limits of budgetary financing after 2000. Since then, a GHG inventory has been prepared annually by KazNIIIEK, including a national CO₂ emission-absorption balance estimated for the forestry sector. GHG inventory data obtained by KazNIIIEK for Kazakhstan can be found on the Web site of the Coordinated Centre on Climate Change.

Table 1. Distribution of forest areas (State Forestry Fund) as of 01 January 2009.

Administrative area	General area of the State Forest Fund ($\times 10^6$ ha)	Forests lands ($\times 10^6$ ha)	General wood store on root ⁽¹⁾ ($\times 10^6$ m ³)	Land cover (%)
Akmolinskaya oblast	1.0	0.4	42.7	2.6
Aktobe oblast	1.0	0.1	1.0	0.2
Almaty oblast	5.0	1.8	38.7	8.0
Atyrau oblast	0.1	0.01	0.5	0.1
West-Kazakhstan oblast	0.2	0.1	8.0	0.7
Zambyl oblast	4.2	2.2	3.4	15.3
Karagandy oblast	0.3	0.2	4.6	0.3
Kostanai oblast	0.6	0.2	16.5	1.1
Kyzylorda oblast	6.7	3.1	6.0	13.6
Mangystau oblast	0.5	0.1	0.1	0.7
South-Kazakhstan oblast	3.4	1.6	3.1	13.6
Pavlodar oblast	0.5	0.2	26.6	1.9
North-Kazakhstan oblast	0.7	0.5	54.4	5.4
East-Kazakhstan oblast	3.6	1.8	175.1	6.4
Republic of Kazakhstan (total)	27.8	12.3	380.7	4.5

Notes: (1) Standing timber stock as of 01 July 2003.

The territory of Kazakhstan is poorly forested, covering only 4.5% of the country. The forests in Kazakhstan unevenly distributed, with about 80% of the wood stock in the northern and north-eastern areas. Forest area distribution by administrative unit is shown in Table 1, based on data from the State Agency for Statistics.

Figure 1 illustrates that *Haloxylon* spp. occupies more than 60% in the general forest area in Kazakhstan. The general standing wood stock amounts to 375.8 million cubic metres, including 140 million m³ of mature and over-mature wood. Despite considerable volumes of mature and over-mature wood (38%), which built up because of limited cutting of deciduous trees and an interdiction on coniferous tree cutting and logging for industrial processing is not a main objective. Since 1991, the official annual wood cutting volume has been reduced from 2.5 million m³ to 1.2 million m³. Forestry activities in Kazakhstan should stress the resource increase and ecological potential of woods. The contribution of woodworking activities to the economy of Kazakhstan was only 2.7% of the gross national product in 1990, and that was several times greater than now. Insufficiently effective reproduction and operation of woodlands demands the introduction of more modern approaches to forest restoration and management.

Figure 1. Shares of various tree types in the forest area of Kazakhstan in 2008.

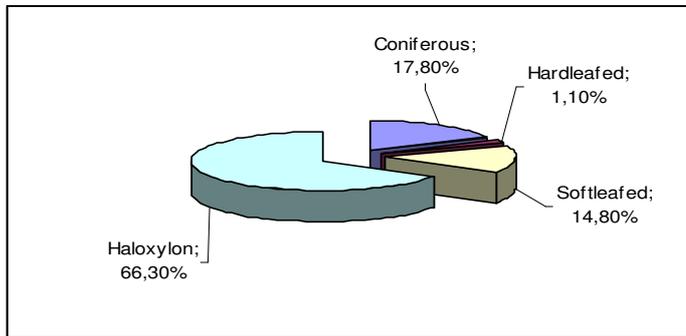


Table 2. GHG absorption by the forests in Kazakhstan.

Year	Stock (Gg CO ₂)
2000	1961.1
2001	1951.7
2002	1929.4
2003	1373.5
2004	1884.8
2005	1708.2
2006	1557.6
2007	1842.4
2008	1961.3

The data in Table 2 show that forests in Kazakhstan represent a positive carbon stock. According to the IPCC Good Practice Guidance (GPG) on GHG inventory in LULUCF (IPCC, 2003) the estimations of GHG emissions and stocks were conducted for two categories: Forest Land Remaining Forest Land (FF); and Land Converted to Forest Land (LF).

In addition, emissions from wildfires were calculated, although most of the fires in Kazakhstan are not a result of human activities, but they are taken into account by the RK Statistics Agency. Also, in the GHG inventory calculations for the LULUCF sector in Kazakhstan, it was considered that all forests in the country are managed.

According to GHG Guidance for LULUCF, the approach of "a change of a carbon stock" for calculation of GHG emission or absorption was chosen. The tree groups are:

- Coniferous – pine, fir, cedar, juniper and similar species
- Softwood deciduous – birch, aspen, alder and poplar
- Hardwood deciduous – oak, ash, maple and elm
- Haloxylon (saxaul) forests – black saxaul and white saxaul
- Other wood – apricot, skeleton, plum, apple-tree, etc
- Bushes – dwarf birch, hawthorn and other bushes.

The basic source of the data on change in wood biomass stocks are results of the inventory of woods in RK conducted every five years (data of the accounts as of January, 1 for 1988, 1993, 1998, 2003 and 2008). During the forest inventory, the area and stock of growing wood of the basic tree groups by age group (Table 3) is determined. Although *Haloxylon* spp. occupies more than 66% of the forest area (Figure 1), they represent only 14.9 million cubic metres, or 3.8% of the whole standing wood stock in Kazakhstan in 2008 (Table 3), while coniferous and softwood deciduous trees formed more than 91% of the total standing wood stock. This is explained by the greater wood and space density, and forest stock height of the latter two categories. Experts from the Kazakh Forest Management Enterprise calculated a coefficient for the average annual gain of woody biomass equal to 1.6 m³/ha, depending on the share of each tree group in the total wood stock.

Table 3. The area ('000 ha) and standing wood stock (million m³) of the main woodland classes in the Republic Kazakhstan.

Year	Tree group											
	Coniferous		Deciduous softwood		Deciduous hardwood		Haloxylon spp.		Other wood		Bushes	
	area	stock	area	stock	area	stock	area	stock	area	stock	area	stock
1988	1737.5	221.1	1303.3	115.6	86.5	2.3	481.2	9.7	43.9	1.0	1410.0	6.5
1993	1800.2	240.4	1406.1	123.3	95.3	2.8	5091.4	10.7	80.8	1.4	2068.8	7.0
1998	1719.0	236.6	1430.5	126.0	98.1	2.9	5421.4	10.2	82.5	1.5	2675.6	9.3
2003	1650.8	228.6	1415.6	131.1	100.0	3.1	6252.8	15.2	137.0	2.6	3094.5	11.0
2008	1606.0	235.4	1378.0	127.2	98.9	3.23	6088.0	14.9	140.1	2.7	2963.2	10.9

Data source: Kazakh Forest Management Enterprise

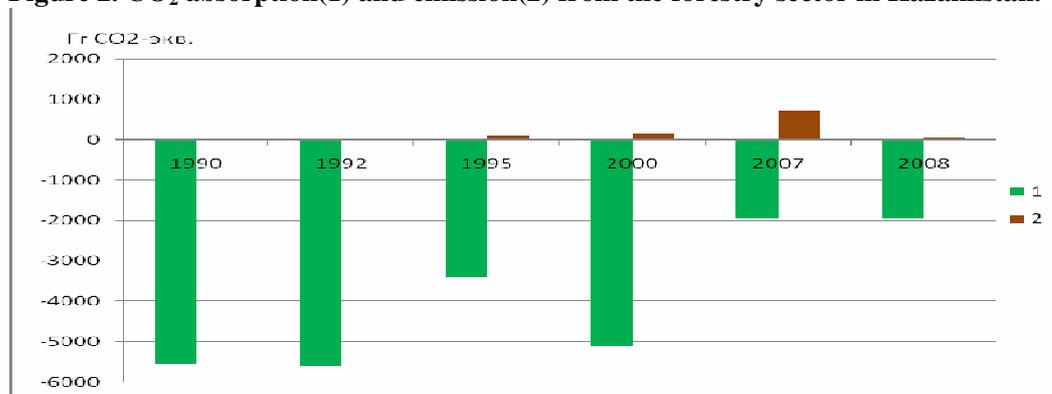
For the GHG emissions inventory in the forestry sector, forest fires were also taken into account. GHG emissions from forest fires are calculated as fire area multiplied by the weight of the burnt wood and application of corresponding emission factors for each gas.

In 2007 the quantity of carbon absorbed by the forests of Kazakhstan were estimated to be 2335 Gg CO₂. GHG emissions from forest fires and wood cutting were 493.1 Gg CO₂. Thus, there was 1842.4 Gg CO₂ absorption in the forestry sector. In 2008, these values were estimated to 1961.3 Gg CO₂ absorption, 39.8 Gg CO₂ emission and a net gain of 1961.3 Gg CO₂ (Table 2).

Figure 2 shows the dynamics of absorption and emission of CO₂ in the forestry sector for 1990–2008. Emissions are basically attributed to forest fires and decomposition of detritus associated with logging. Stocks are connected with change in absorption of carbon by elevated parts of live biomass ("FF" category). Thus the contribution of the coniferous and softwood deciduous trees to carbon uptake is about 80%.

The Law on "About woods and wood plantings", and "The Wood Code", etc., ban the cutting down of coniferous and *Haloxylon* spp. plantings, which is positive for preservation and restoration of woods. In the "Wood Code" and the associated programme "Woods of Kazakhstan", confirmed by governmental order No. 542 of 14 May 2004, emphasis is placed on the implementation of a complex of actions for protection and reproduction of woods, and their rational use. The given measures, undoubtedly, will lead to stabilization and improvement of the condition of woods in Kazakhstan, especially during the upcoming global climate change. At the same time, the issue of climate change is not directly taken into account in these documents.

Figure 2. CO₂ absorption(1) and emission(2) from the forestry sector in Kazakhstan.



Further climate change studies in Kazakhstan

During 2004–2007 further climate change studies were conducted within the research programme of MEP. The research theme was “Estimation of regional climate change, climate change vulnerability and adaptation of ecosystems and climate-dependent branches of the economy, as well as climate change scenarios development under GHG concentration increase in the atmosphere.” Additional studies on climate change were conducted within the UNDP/GEF project on the preparation of the Second National Communication (SNC) of the Republic of Kazakhstan to UNFCCC.

Briefly the results of these works are as follows. The observed annual temperature trends for the last 50 years in Kazakhstan were positive, increasing by 1.5°C. Taking into account that the greater part of the territory of Kazakhstan is occupied by deserts and semi-deserts, their ecosystems and many economic sectors, especially agriculture and water resources, are very vulnerable to climate change. According to climate change scenarios based on global climate modelling, further temperature increases with no significant gain in atmospheric precipitation may lead to a drier climate. In parallel, the climate zone boundaries may shift northward, and wheat yields may be reduced more than by 25%, grassland productivity may be reduced by 30–90%, and sheep breeding is expected to be unfavourable.

Some attention was given to research into climate change influences on the forests of Kazakhstan. The uncontrollable cutting of wood; forest fires, caused by both weather conditions and humans; less tree planting and forest rehabilitation works; and damage by insect pests—all these may lead to a reduction in the wood resources of Kazakhstan. Shifting climatic zones can lead to the destruction of wood ecological systems. Areas of particular forest communities could be reduced or even disappear.

As a whole, research into the effects of possible climate change in Kazakhstan has revealed a high degree of vulnerability of the economy to the expected anthropogenic climate change. Moreover, the expected negative consequences of these changes for Kazakhstan far outweigh the positive.

Surface air temperature trends in Kazakhstan

Between 1936 and 2005, based on observation data from over 90 meteorological stations in Kazakhstan, the calculated linear trends in the mean air temperature time series and the sum atmospheric precipitation show that the climate of Kazakhstan in the period became significantly warmer. Winters in Kazakhstan are getting warmer, on average by 0.5°C per decade, while warming less in summer, at 0.2°C per decade, implying in general an overall warming of 0.3°C per decade.

Comparison of seasonal trends in different regions shows the east shore of the Caspian Sea increasing by 0.7°C per decade, while the positive tendency in winter is less, at 0.2°C per decade). The number of hot days is rising considerably in the regions of Kazakh hummocky topography (2.4 days per decade), but only 2.0 days per decade in the district of Mangyshlak. The number of cold days is decreasing in all regions of Kazakhstan, especially in the west and southwest of Kazakhstan, from minus 4.6 days to minus 7.7 days per decade in the district of Mangyshlak.

In all regions of Kazakhstan there is a reduction in the number of cold days, while the number of hot days in desert regions is increasing. A temporary tendency of extremely high daily temperature has a positive character in all Kazakhstan. Night temperatures are increasing considerably more than day temperatures. There are exceptions to this, such as in the higher areas Kazakh hummocky topography, Gorny Altai and the district near the Dzungaria Gates. It shows that nights (also in winter) in most parts of Kazakhstan are warming, and accordingly the daily and annual amplitude of air temperature is decreasing. In turn, it indicates decreasing continentality of the climate of Kazakhstan.

Climate change scenario constructions in Kazakhstan

While developing climate change scenarios, five double models of common atmospheric and ocean circulation were used, and five scenarios of atmospheric exhaust fumes concentration, as given in IPCC. The 1961 to 1990 period was accepted as the base period.

From the information in Table 3, the worst precipitation conditions derive from the “hard” scenario, where by 2085 there may be a northward zonal shift of 250–300 km. In this situation, all the northern districts of Kazakhstan will be in the semi-arid zone and the semi-arid zone will cover a very wide area. Other scenarios indicate much less of a northward zonal shift.

Research into regional climate change scenarios for use in the research on the assessment of influences on southern and eastern Kazakhstan pastures indicated air temperatures rising in all seasons of the year in this region.

Table 3. Changes in average annual surface air temperature and annual total precipitation according to “hard”, “medium” and “soft” scenarios of GHG concentrations.

Scenario	Climate characteristics	2030	2050	2085
Medium	Change in average annual air temperature	1.4°C	2.7°C	4.6°C
	Change in total annual precipitation	+2%	+4%	+5%
Extremely high (hard)	Change in average annual air temperature	1.2–1.9°C (1.3°C)	2.5–4.0°C (3.0°C)	5.7–8.0°C (6.2°C)
	Change in total annual precipitation	-2– +8% (2.2%)	-4– +15% (3.7%)	8–28% (6.5%)
Extremely low (soft)	Change in average annual air temperature	1.5–2.2°C (1.7°C)	1.6–2.6°C (2.0°C)	3.1–3.4°C (3.3°C)
	Change in total annual precipitation	0-8% (3.0%)	-3– +9% (1.7%)	-2– +13% (4.1%)

Climate Change Vulnerability Assessment

While SNC was being prepared, additional research considered vulnerability and adaptation to climate change.

Spring wheat. The main districts for sown cereals are located in the north of Kazakhstan, an area of marginal agriculture. Even under the medium scenario of climate change, there will be worsening of the climate conditions for cultivation of spring wheat, that could cause a sharp decrease in crop yield: some 25–60% in Kostanay, Akmola and Pavlodar regions; and 70–90% in north Kazakhstan. Increased air temperatures will have a negative influence on plant development, which will cause a considerable decrease in crop yields.

Grassland. Under the medium scenario of climate change, the condition of the pasture area of Kazakhstan will change for the worse due to reduced precipitation. The future of pasture under the influence of climate change will be evaluated in terms of loss and increase of fodder crops on sown areas. To 2030, reduction will be of the order of 40 t/ha, and 80 t/ha by 2085. For submontane pastureland, under the medium and hard scenarios for climate change, an increase of fodder units from 61 to 115 t/ha could occur annually, with the main increases (60–90%) in spring and early summer periods.

Sheep breeding. Sheep breeding is the main livestock sector in Kazakhstan. Economic reasons led to the number of sheep and goats in the republic decreasing from 36.7 head in 1987 to 9.5 million head in 1998, although by 2007 they had increased to 17.7 million head. For the last 40 years, the

average number of non-pastoral days in the cold half of the year fell to 6 days from 11, showing the easing of sheep pastoral conditions in the south of Kazakhstan. Also, the combination of a warming climate and systematic organized sheep breeding may avoid significant decrease in sheep production.

Water resources. As a result of climate change there will be increased requirement for water, nationally in order to support needs of the population and industries of Kazakhstan, and regionally for neighbouring countries that depend heavily on water resources that originate in Kazakhstan. Under the influence of anthropogenic change of climate the water resources will increase in the mountain districts, while decreasing in agronomic districts.

Forestry. In terms of percentage of forest land, Kazakhstan stands low in the global list, although the area per person in Kazakhstan, at 0.77 ha) is the same as the United States of America and Malaysia, and more than in several East European countries. With a possible move to the south in mountain regions, the resistance of forest ecosystems implies eco-climatic zone boundary disturbances. The temperature and humidity changes may cause unsuitable conditions for pine, fir, larch and cedar, and thus lead to changes in species compositions, with an increase in less valuable deciduous trees and shrubs. In mountain regions, the lower limit of spruce moving upward by 100–120 m will give way to deciduous softwood species and fruit trees. Fir plantings may disappear from the territory of Zhetisuiskiy Alatau, and they will remain only in a small area of East Kazakhstan.

This high vulnerability of forestry to climate change is explained by the circumstances that the main species, such as pine, fir, cedar and juniper, are at the southernmost border of their area, and are very sensitive to temperature and humidity regimes. Junipers grow on the northern border of their area and also are capable of reacting to changed climatic conditions.

Climate change adaptation and mitigation policies in Kazakhstan

The Republic of Kazakhstan ratified the Kyoto Protocol in September 2009, and started actively participating in the international negotiation process on climate change mitigation and further GHG reduction. Climate Change issues are considered a very serious problem in the Concept of Ecological Security for 2004–2015. It implies further climate change studies of climate tendencies and assessments of climate change impacts. The Ecological Code of the Republic of Kazakhstan, which was accepted in January 2007, introduced accounting and control of GHG emissions both at the country level and at an enterprise level, with the goal of mitigating climate change impacts. The necessity of adaptation to climate change is still not included in governmental legislation. However, the development of the Adaptation Strategy of the Republic of Kazakhstan is one important part of the Plan of Action of the Ministry of Environmental Protection - Road Map for 2010. Since 2009, Kazakhstan has been developing a strategy on low carbon economic development.

The percentage of wooded land in Kazakhstan, including *Haloxylon* spp. and bushes, is 4.5%, while forests are only 1.2%. Nevertheless, despite their small size, the forests play an important role in soil protection, in climate and water regulation, water protection and in recreation. The forming of a propitious environment for stable forest regulation takes on an important significance in climate change conditions. Aiming at realization of the governmental regulation of the Republic of Kazakhstan, No. 319 of 20 April 2007, the programme “Zhasyl EI” for 2008–2010 was developed and ratified, No. 958 of 16 October 2007. It plans to create forests on 145 180 ha, and set the pattern for future work on forest protection and expansion. The problem of protecting, restoring and sustainably using the biological and landscape diversity has been made difficult in the absence of scientifically grounded recommendations and measures to protect and reclaim of bio- and landscape diversities, and the limited resources in terms of plantations and genebanks.

Review of status and work by national research institutions on research for assessment of climate change

Currently, research on climate change in Kazakhstan is provided in The Kazakh State Climate and Ecology Research Institute, in the State Republican Enterprise “Kazhydromet”, and in the Coordinating Centre on Climate Change, which is a non-governmental organization (NGO). By order of the Ministry of Environmental Protection, between 2004 and 2007 there was research into the influence of global climate change on the economy and natural resources.

The Ministry of Environmental Protection is the national authorized body of the government, accomplishing regulation and inter-sectoral coordination in terms of developing and realizing state policy in the sphere of environmental protection and nature management regulation. National projects in the sphere of climate research are coordinated by the Ministry, including institutional and real sector projects, projects of societal access to ecological information on adaptation to climate change and on GHG emission reduction. The Ministry also develops legislation for realization of its obligations under the UNFCCC and the Kyoto Protocol.

Currently the Ministry of Environmental Protection has a programme «Zhasyl Damu» (Green development) for 2010–2014, the main purpose being to improve environmental quality and to support sustainable ecological development of society. One of the three elements of the programme, “Protection and restoration of natural ecosystems”, addresses transition to sustainable development, climate change, biodiversity saving, coping with land degradation, areas of ecological disaster and polluted territories.

State Republican Enterprise “The Kazakh State Climate and Ecology Research Institute” (KazNII EK)

One of the main tasks of SRE KazNII EK is to satisfy international obligations taken under UNFCCC and other international agreements, as well as to form and implement government ecological policy in the sphere of hydrometeorology and environmental monitoring. Since 2000, KazNII EK, by the order of the Ministry of Environmental Protection, has worked on GHG inventory in Kazakhstan. The resulting GHG inventory is presented to the government annually, and adds to the national reports on environmental conditions in the Republic of Kazakhstan.

In the frame of climate change for 2010, the Ministry of Environmental Protection entrusted to KazNII EK to develop the concept of low-carbon development and a strategy on climate change adaptation. KazNII EK is working of this with the support of the UNDP/MEP project “Strengthening capacity in the field of sustainable development through integration of climate change issues into strategic planning in the Republic of Kazakhstan”.

State Republican Enterprise “Kazhydromet”

Kazhydromet activities related to climate change problems include:

- hydrometeorological monitoring;
- assessment and climate forecasting;
- hydrometeorological mechanisms and climate change studies;
- long- and short-term weather forecast methods development and improvement;
- research into climatic, hydrological, agricultural and meteorological resources and changes under natural and anthropogenic factors; and
- complex studying of natural meteorological phenomena and meteorological regime of the Caspian Sea, Aral and Balkhash Lakes, the Baikonyr spaceport, and adjoining territories.

Kazhydromet provides systematic observations from 251 meteorological stations, which form the basis for climatic monitoring. There is a scientific branch that provides climate research and its assessment, and also is working on scenarios of climate change. The scientists of Kazhydromet work on climate change vulnerability and adaptation assessment, and took part in the SNC preparation.

Non-governmental organization “Coordination Centre on Climate Change”

The NGO Coordination Centre on Climate Change (C4) is active in climate change works and is the first NGO working in the sphere of UNFCCC and the Kyoto Protocol. C4 was established in 2002. Specialists of C4 formed working groups on project realization in the sphere of GHG reduction. It allowed a demonstration to the community of Kazakhstan of the possibility for realizing such projects, their benefits both for the individual citizen and for the national economy. C4 operates as an independent organization attracting financial resources in order to address Kazakhstan’s global ecological problems. Environmental protection decisions are impossible without a corresponding legislative basis, and the Centre participates in improving and harmonization of the legislative basis of Kazakhstan to implement obligations under international ecological conventions.

C4 supplies expert support to realization of the Kyoto Protocol mechanisms. National partners of C4 are KazNIIIEK, Kazhydromet, the public association “Karaganda Oblast Ecological Museum”, and others. It has held many seminars and meetings on environmental problems, particularly in the area of protection of the ozone layer and global climate change.

Public Association “Karaganda oblast Ecological Museum” (Ecomuzei)

The NGO “Ecomuzei” supports the collection and dissemination of ecological information in the territory of central Kazakhstan in order to improve the role of society in decisions on topical ecological problems, and democratic processes in development of society. One of the main objects of Ecomuzei is adoption of new effective ecological technology, including building of biogas installations. In 2006, “Ecomuzei” organized the first Central Asian conference on sustainable energy.

Institute of Botany and Phytointroduction of the Ministry of Education and Science

In accordance with global climate change, the Institute of Botany and Phytointroduction works actively on protection of biodiversity and further planning to provide research on conformity and dynamic conditions of vegetative cover. There is a need for long-term biosphere stationary monitoring, realization of permanent monitoring conditions of vegetative cover coupled with observation of climate change effects on vegetation. The Institute of Botany and Phytointroduction in Kazakhstan developed a project for ecology-based monitoring of vegetative cover in global climate change.

The necessary control database for analyses of anthropogenic changes in vegetative cover and changes associated with climate change, could be developed on the basis of earlier surveys of the biological properties of the types of plants and vegetative cover in nature and cultivation. In this context, the main value of the research is the amalgamation of data from other teams of researchers, including the Institute of Botany, forestry, agricultural afforestation, agriculture, grassland agriculture, pedology, plant physiology, Kazakh Agriculture Institute, Institute of Phytophysiology, Institute of Soil Science, Kazakh Al-Farabi National University, botanic gardens and nature reserves. Unfortunately, today we have no reliable methodology to assess climate change influences on the vegetative cover. Accordingly, the primary task is to elaborate methodical approaches to the assessment of climate factor influences on the dynamics of vegetative cover and to the biota as a whole.

The trend in natural resources and vegetative cover changes in Kazakhstan may be considered as a fast-growing disaster. But Kazakhstan is not ready to assume the measures to protect it, because mechanisms of changes are not sufficiently understood and there is little or no monitoring. It depends on a number of reasons, including human resources, economic conditions and financial provisions for research activities and their support by the State. Also there is no State scientific policy identifying the direction and work strategies concerned with global climate change. Global climate change requires that monitoring of vegetative cover be a main priority in the sphere of botanical and ecological research.

The Kazakh Forest Management Enterprise

The Kazakh Forest Management Enterprise is a state institution under the Committee of Forestry and Hunting of the Ministry of Agriculture. The main object of its activity, defined by the Wood Code of the Republic of Kazakhstan, is working out a complex of measures on maintenance and rational use of forestry and wood resources, optimal reproduction, protection and protection of woods based on reliable information regarding wood resources. Realization of an electronic databank on the forest fund will promote creation of a state wood cadastre and monitoring of woods; to define volumes for sustainable forest use; actions for reproduction of forests; and control of activities by establishments in forest management projects.

The enterprise conducts the state accounting of the forest fund, the purpose of which is to provide state bodies and interested legal and physical persons with the operative information on condition and dynamics of the national forest fund. The documentation is updated every fifth year. Between each five-year accounting, annual accounts of the wood fund are maintained under a special form (areal data).

The enterprise plays an important role in forest management. However no activity related to climate change impact and adaptation has so far been undertaken, and there is a lack of information in this area. Carbon sequestration by the forests of Kazakhstan may be significant because huge territories with trees are outside the system of forest accounting. There is a need to improve the inventory of the forests in Kazakhstan.

International projects

Among current international projects concerning to a certain degree climate change impact issues, there is a UNDP/GEF project “Conservation and Sustainable Use of Biodiversity in the Kazakhstani Sector of the Altai-Sayan Ecoregion”. The main objective of the project is to enhance the sustainability and conservation effectiveness of Kazakhstan’s national protected areas system by demonstrating sustainable and replicable approaches to conservation management. It focuses on several important economic sectors, including agriculture (livestock production, farming, fishery) and forestry in the region. Although there are no direct indications of climate change adaptation issues, it will undoubtedly also promote adaptation of these sectors to climate change impacts.

Another climate change-related project is being implemented in the frame of the UN Convention to Combat Desertification. Since 2005, the Central Asia countries have collaborated in a complex regional programme “Central Asian Countries Initiative on Land Management” (CACILM). The purpose of the programme is strengthening the potential for sustainable management of land resources; mobilization of investments for project realization on rational use, restoration and prevention of land degradation, especially for rural territories; increase in standard of life and their attraction to programme realization.

Projects on adaptation to climate change are implemented currently only in the framework of the UNDP/GEF Small Grant Programme. Since 2009, several small projects have been realized at the level of rural communities, on water resources savings, rational irrigation and horse breeding.

Less attention has been paid to issues of climate change impact on forestry and its adaptation to the expected climate. There are no projects on carbon accounting in the LULUCF sector.

Summary list of proposals to identify possibilities for collaboration between FAO and national institutions and specialists

Below is a list of proposals identifying possibilities for collaboration between FAO and national institutions and specialists:

- Elaborating methodological approaches to the assessment of climate change influence on dynamics of vegetative cover and the whole biota. (Institute of Botany and Phytointroduction, with KazNIIK)
- To develop a modern agro-climatic informational scheme to support food safety and to decrease desertification processes on the arable lands of Kazakhstan. (KazNIIK as coordinator)
- Assessment of potential carbon uptake of forests in the Republic of Kazakhstan as a result of reforestation and forest recreation on the land of the forest fund.
- Improvement in the system of care of protective forest belts and protection of woods against fire.
- Creation of plantation timber to increase the wooded areas in operated boreal and moderate woods.
- Assistance to natural forest recreation for the increasing of forest care areas.
- Actions for care of wood culture with a gain in the areas of forests.
- Reforestation and creation of protection planting in desertification areas.
- Preventive maintenance in forests.
- Preservation of pine forests in the east of Kazakhstan under threat from potential climate change.
- Improving forest exploitation under conditions of global climate change.
- Introduction of a carbon accounting system in the forestry sector of Kazakhstan on the basis of the state account of the forest fund.

References and other sources used

- Baitulin, I.O., Proskuryakov, M.A. & Yesserkepova I.B. 2010. Ecological doctrine of vegetation mantle monitoring of Kazakhstan in a view of global climate change. *Hydrometeorology and Ecology*, in press. [in Russian].
- Blagovechshenskiy, V. et al. 2003. The Experience of the Use of NXD2000 Program for Avalanche Forecasting at Zailiyskiy Alatau Range. *Data of Glaciological Studies*, 94: 115–118.
- Blagovechshenskiy, V., Kondrashov, I., Gassner, M., Laternser, M.A. & Yesserkepova, I.B. 2001. Experience with the NXD2000 Program for Avalanche Forecast at Zailiyskiy Alatau Range. pp. 138–140, in: *Proceedings of the International Scientific and Practical Conference “The Problems of Hydrometeorological and Ecological Problems”*, celebrating the 50th anniversary of the Kazakh Research Institute of Environmental Monitoring, Almaty, 2001 [in Russian].
- Chichasov, G.N. & Shaven, A.M. 1997. Long-period climate changes and their consequences for grain in the Kazakhstan economy. *Hydrometeorology and Ecology*, 3: 29–42 [in Russian].
- DiNicola, A. 1997. Steps in preparing forestry and biodiversity sections of climate change action plans. Development and evaluation of forestry and biodiversity mitigation measures. *Hydrometeorology and Ecology*, 3: 150–154.
- Dolgikh, S.A., Eserkepova, I.B. & Shamen, A.M. 1997. Assessment of global climate warming contribution in the desertification process development in Kazakhstan. *Hydrometeorology and Ecology*, 3: 43–49 [in Russian].
- IPCC. 2003. IPCC Good Practice Guidance (GPG) on GHG inventory in LULUCF.

- Mizina, S., Eserkepova, I.B., Pilifosova, O., Dolgikh, S., Gossen, E. 1996. Model-Based Climate Change Vulnerability and Adaptation Assessment for Wheat Yields in Kazakhstan. pp. 148–163, in: *Adapting to Climate Change: An International Perspective*. Springer-Verlag, New York, USA.
- Pilifosova, O.V., Eserkepova, I.B. & Dolgikh, S. 1997. Regional Climate Change Scenarios under Global Warming in Kazakhstan. *Climatic Change*, 36: 23–40.
- Shivaryova, S.P. et al. 2009. Influence of climate change in the water resources of Balkhash Lake and the Aral Sea basins. *Hydrometeorology and Ecology*, 3: 36–61. [in Russian]
- Yesserkepova, I.B. 2008. Constructing Model-Based Climate Change Scenarios for South-eastern Kazakhstan and the Possibilities for Impact Assessment. pp. 163–172, in: Jiaguo Qi et al. (editors). *Environmental Problems of Central Asia and their Economic, Social and Security Impacts*. Springer.
- Yesserkepova, I.B. 2000. Country Paper and Discussions: Kazakhstan. pp. 46–51, in: Report of the NCCSAP Workshop, 27–28 November 2000, Amsterdam, the Netherlands. Netherlands Climate Change Studies Assistance Programme.
- Full report of Working Group I “The Physical Basis of Climate Change”, NCAR, 2007. (www.ipcc.ch).
- First National Communication of the Republic Kazakhstan under the UNFCCC. Almaty, 1998.
- Second National Communication to the Conference of the Parties of the UNFCCC. Astana, 2009. See: unfccc.int/resource/docs/natc/kaznc2e.pdf
- www.climate.kz
- www.eco.gov.kz
- www.ecoclimate.kz
- www.meteo.kz
- www.ecomuseum.kz
- www.climate.kz/eng/?m=html&cid=26
- www.un.kz
- www.undp.kz/projects/start.html?type=internet
- www.oopt.kz/podvedomst_org/rkgp/kaz_lesstroi/

KOSOVO

Ergin Hajredini

Summary of climate change dimensions

Introduction

This report provides a general description of forestry conditions in Kosovo, as well the impact of global climate change on forestry. Baseline data on topics such as forest vitality, health and yield, all of which are important to show the impact of global climate change on forest resources, are not available. Only one inventory, with the primary object of monitoring and assessing standing volume, quality classes and yield, has been undertaken, in 2002–2003, covering both private and public forest areas. This remains the only available national data. A second inventory, which was supposed to be undertaken within 5 years, could not be done because of lack of budget. The data existing on forestry in-country is insufficient to analyse change in forest health, yield and mortality.

After 1999, forestry in Kosovo was supported by various international donors, with the primary objectives of institutional capacity building, organization and training. Reflecting the recent conflict in the country, the priorities for government institutions were in other fields, such as infrastructure, rebuilding war-damaged housing, and health concerns. Apart from lack of human resources, limited budgets preclude the possibility of undertaking research activities and monitoring in the forestry sector.

In 2006, the Kosovo Forestry Agency, through the support of the Norwegian Government, developed methodology for preparation of management plans (10-year plans), where some 40 000 ha of public forests was covered out of the total 278 000 ha. The results show the extent of dead trees, which is approximately 2.3% of total volume. The reason could be either climate change or inappropriate management. The majority of Kosovo's forests are unthinned, so there is urgent need for thinning activities. High tree density in forests might be the reason for dead wood. In the absence of previous time-series data, no comparison can be made.

Kosovo is a country in development with a simple economy. As the primary energy source for the country is coal, future economic development can be expected to lead to increased CO₂ emissions. There is no data regarding GHG emissions. The only data that might be used as a source of information are data from 1985–1989, but that is outdated in view of the political, social and economic changes since then. There is no study or related research on this subject. Kosovo is not a Party to UNFCCC. It is crucial that, in the near future, Kosovo should establish a body responsible for policy-making and which would be responsible for actions on climate change.

Kosovo has to start preparation of an action plan for forest protection against illegal activities. With political changes in the country, Kosovo has also to implement responsibilities that derive from the Kyoto Protocol. However, this will require strengthening of the organization and human resources of institutions, and technical capacity building. Law enforcement activities will need to be supported by funds from government and possibly also through international donor support. An immediate positive impact would derive from measures such as using biomass as an energy source, an area where Kosovo has little experience, even though there are plenty of resources for biomass production. There is a big area of forest classed as coppice forest, which needs urgent treatment to improve quality and optimize possible production. The main products from this type of forest are small diameter timber which can be used for biomass production. To achieve this, best practices from other countries need to be introduced, as well appropriate technology, since there is no local expertise. In the end, there is the need to establish a regular monitoring system, such as a national forest inventory, to monitor adaptation to the effects of climate change.

Current situation in forestry and biodiversity

Information about Kosovo

Kosovo is located in southeastern Europe, and is characterized by its central position in the Balkan Peninsula, being surrounded by Albania, Macedonia (FYR), Serbia and Montenegro. The country is a geographical basin, with a total land area of 10 877 km², situated at an altitude of about 500 m, surrounded by mountains and divided by a central north–south ridge into two subregions of roughly equal size and population. It enjoys a continental climate, with temperatures ranging from -20°C during the winter to +40°C during the summer. Average annual rainfall is 720 mm. In the western areas (Peja, Gjakova), precipitation increases to between 900 and 1000 mm, while areas in the north (Mitrovica) and centre and east (Pristina, Lipjan) are considerably drier, with annual average precipitation of circa 600 mm. Most rainfall occurs during the May-June and October-January periods. February, March and August are the driest months.

Kosovo has a varied geology that ranges in age from the Neo-Proterozoic to the Holocene. The geology is characterized by substantial structural features on a regional scale, including normal faulting and thrusting. Soils are relatively free-draining and fertile, with an average pH value of 6. Overall the conditions for forestry are quite favourable, with no pronounced dry periods or other extreme conditions.

Forestry and biodiversity

The national forest inventory, which was completed in 2003, estimated the total forest area to be 464 800 ha, or 42% of the land area. Some 278 880 ha are public forest lands and under the control of the Kosovo Forest Agency (KFA), which is organized into six geographical regions. The KFA has a regulatory function in relation to the 185 920 ha of private forest lands. Broadleaved forest, created through natural seeding, accounts for more than 90% of the forest area, with the main species being oak and beech. Coniferous forest, covering 7% of the total forest area, is dominated by *Abies alba*, *Picea abies* and *Pinus* spp.

The total standing volume on public forestlands was estimated at 33.5 million m³ and in private forests circa 19.5 million m³. The gross annual increment is approximately 1.3 million m³. The inventory estimated the annual allowable cut as being of the order of 900 000 m³ gross, corresponding to 77% of the calculated increment on the areas surveyed. About 700 000 m³ would be harvested in high forest and about 200 000 m³ in low forest. The main harvesting operations in Kosovo are cleaning and thinning. The road infrastructure is relatively poor, with a low road density and lack of maintenance in recent years. This has resulted in harvesting concentrating in areas with easy access and increasingly the allowable volume is located in remote areas where access is difficult. Official harvesting is currently some 200 000 m³ per annum. Since the war, the majority of timber harvested is used for fuelwood and this is the main source of heating, even in some urban areas. The demand for fuelwood is currently great and some analysts estimate that the national requirement is close to 1 million m³ per annum.

Afforestation in Kosovo has averaged around 240 ha per annum in recent years and is mainly of coniferous species. There is one forest nursery, in Peja, under the control of the Forest Research Institute, which produces circa 700 000 seedlings annually. The main species are pines (*Pinus Nigra* and *Pinus sylvestris*), spruce (*Picea abies*) and Douglas fir (*Pseudotsuga taxifolia*). Each year KFA allocate some 10% of seedling production to the private sector. Continued planting of coniferous species in future should be reconsidered with regard to stability if climate change affects ecosystems. To date the success of afforestation has at best been considered as mixed, whether undertaken by KFA or the private sector.

A 2001 Forest Sector Study concluded that the annual value of products and other benefits from forests and forest lands was in the range of € 50–75 million. The current contribution of the forestry sector to GDP is estimated at between 1.8% and 2.6%. The inventory estimated that some 40% of public forests and 29% of private forests have been subject to uncontrolled or illegal harvesting activities. The inventory results also confirm expert opinions that coppice forest, especially public owned, is exposed to heavy harvesting for fuelwood. The results also show that many young and middle-aged forests are in urgent need of management interventions, ranging from cleaning and pre-commercial thinning to commercial thinning.

Forests are a key resource for the economic, social and environmental well-being of the people of Kosovo. A high proportion of Kosovo's biodiversity is forest based, and forest management will have a key future role in meeting Natura 2000 network requirements under the EU Birds and Habitats Directives. Forests are also diverse ecosystems. They provide a wide range of important habitats, give shelter, reduce the levels of CO₂ in the atmosphere, act as "green lungs" in urban areas, add to the diversity of the landscape and ultimately to the quality of life. Forests are also a source of non-wood products. These include wild fungi, berries, fruits, nuts and the products derived from them (jams, jelly, juices, etc.), honey, sand, gravel and stone/minerals. There are also possibilities to develop hunting and agro-cum-eco-tourism. The multiple benefits of forests can only be assured if they are managed wisely and in line with principles of sustainable forest management (SFM).

Forest management

The management plans in most public forest areas have expired and valid ones are outdated. The ministry every year produces new management plans (for approximately 8 000 ha) through its own budget, but budget limitations prevent more expansive plans. In future years, as management plans are prepared for the publicly owned forest areas, it will be possible to use the data. However, in private forestry there is lack of best practices for forest management, even though some 40% of the total forest area in Kosovo is private property.

Illegal activities in both public and private forests are a big challenge for the future of forestry. A national strategy is needed to stop illegal activities and to find the best solution. Most old forest has been cut, where the average age of forest from the national forest inventory is between 40 and 50 years old. There is an urgent need for silviculture treatment to improve the quality of growing stock.

Since the main biodiversity in Kosovo is in the forest, the exact location of biodiversity hotspots is unknown. Those areas should be mapped with coordinates, after inventorying them. This will help forest operator to pay special attention to those areas during harvesting and extraction of timber from forest areas.

Legislation and policies

The law that is in force and that directly affects the forest sector is Law No.2003/3, on Forests in Kosovo. So far the new law has been complemented by seven Administrative Directives, and a Wildlife Management Law. The new legislation defines the mandate, responsibilities and tasks of the different actors involved in forestry. The new law provides a basis for sustainable forest management and efficient forest land use. In general, the new law is built on principles of major global policies on sustainable forest management, such as: a precautionary approach, conservation of biological diversity, intergenerational equity and ecologically sustainable development, as set forth in Annex III to the Report of the United Nations Conference on Environment and Development (UNCED) (Rio de Janeiro, 3–14 June 1992). Based on such criteria, all international communities of democratic society with a free market economy system, including both developed and developing countries, should try to adjust their forest management systems. A similar effort is proceeding in Kosovo.

According to the law in force: *“the forests of Kosovo are a national resource. It shall be managed in such a way as to provide a valuable yield and at the same time preserve biodiversity. Forest management shall also take into account other public interests.”*

The new law on forestry is of great importance for the forest sector in Kosovo. The new law incorporates disclosure, transparency and sustainability in forest management, as well as new approaches, and a move toward free market-oriented economy in forestry. The main actors identified for the forestry sector in Kosovo are the Ministry of Agriculture Forestry and Rural Development (MAFRD) Forestry Department (FD) and the Kosovo Forest Agency (KFA), with its regional and municipal units. Other relevant stakeholders in the sector are various NGOs (Association of Wood Processors of Kosovo; Association of Private Forest Owners; Association of Forestry Engineers; Era-association; Ecological Association Prizren; Hunters' Association; etc.), Private Operative Contractors, Courts, Kosovo Police Service (KPS), non-wood product collectors and local communities. Stakeholders' activities have been minimal until now, despite their role and responsibilities to represent and address the interest of the members regarding sustainable forest management through coordination, advice and general support in the interests of the members at national level. They are at the initial stage of their growth. So, under the present circumstances, they do not represent a strong lobby that can influence the decision-making process. The situation must be changed rapidly in the near future.

If Kosovo's forest resources are managed in a sustainable way, then it is possible to fulfil most of the needs of population for fuelwood and possibly lumber as well (the needs of the population for lumber wood are not known due to the absence of any assessments). At the moment, domestic production capacities are not exploited as much as they should, due to the lack of management plans and lack of road infrastructure, as well as neglect through limited financial commitment to forest activities by the government.

One of the most urgent needs for the forest sector in Kosovo is to compose a “Strategy and Policy on Development for Forests”. Due to the lack of any development strategy in the forest sector, many problems arise, especially for the department planning management, and problems due to the lack of a strategy have ramifications for the whole forest planning and exploitation process. The cost of drafting managing plans, plans for opening new roads, the inclusion of the needs and interests of the community, and that of the wood processing sector, all of these problems are closely linked to the development of the forest strategy. Thus, MAFRD and KFA need technical and financial assistance from investors in order to develop a comprehensive forest strategy.

The Law on Nature Conservation (2006/22) is the principal legal instrument that governs nature conservation and biodiversity in Kosovo. There are also other laws that regulate activities related to nature conservation and biodiversity. A list of relevant laws is given below:

- Law on Nature Conservation (2006/22)
- Law on Protection of Environment (2003/9)
- Law on Water (2004/41)
- Law on Spatial Planning (2003/30)
- Law on National Park Sharri Mountain (1986)
- Law on Forests (2003/6), (2004/40)
- Law on Hunting (2006/41)
- Law on Fishery and Aquaculture (2006/58)
- In addition there are a number of administrative instructions on:
 - Evaluation of Environment Impact (No.09/2004-MESP)
 - Form and manner of maintaining a Central Register of nature conservation zones (No.04/2006-MESP, September 2006)

- Marking method of nature conservation zones (No.01/07-MESP, December 2006)
- Issuance of ecological permit (No.26/05-MESP, 07.11.2005)
- Licensing individuals and enterprises for drafting evaluation report on environment impacts (No.03/2004-MESP)
- Criteria for identification of water conservation areas and measures for conservation of drinking water resources (No.13/07-MESP)
- Implementation of Law on spatial planning on main elements of plan content for areas of special importance (No.2005/42-MESP, 04.03.2005)
- Decisions on conservation areas (a total of 75 habitats).

Status of assessment and research on climate change

Capacity and research institutions

Kosovo governmental institutions do not have sufficient budget and capacity for monitoring forest resources in terms of impact of climate change. Before 1999 in Kosovo, the main data collection for research purposes were done by forestry research institutes, including inventory, health monitoring and other research in forestry within the country. Most professionals engaged in the activities were from the Forestry Institute in Belgrade, which was the main body for data processing and data analysis. After 1999, there were few forestry experts in the country. Beside the lack of human resources, the Institute has very small budget, and the main activities have been seedling production. During reorganization of the Ministry of Agriculture Forestry and Rural Development (MAFRD), there have also been changes in forestry. Today the forestry institute no longer exists. Most professional activities such as forest inventory or forest management planning are done by private professional companies.

There is one professional private company currently licensed by MAFRD, which provides extension services for KFA. This company is specialized and well equipped with modern technology, such as GIS and remote sensing, with well trained staff for inventory, management planning and monitoring. Their activities depend on the budget available to government institutions, which sometime are very low. All management plans based on the procurement law in Kosovo should be executed through tendering with private contractors, as well other measures like national forest inventory or harvesting operation.

Projects and research

Forestry in Kosovo has passed through many challenges. Since 1990, forest resources have been overused. The same situation continued during and after the war. Most forest operations were in the most accessible areas, while remote areas with no road access were ignored. There have been some investments, mainly in increasing technical capacities, but no major investment. Government institutions have very little budget to support forestry, which means forestry is not a priority.

Within the last 10 years several projects have been implemented in the forestry sector to improve management, based on EU standards, including:

- Emergency phase in Forestry (1999–2003)
- National Forest Inventory (2002–2003)
- Forest management planning with GIS (2006–continuing)
- Sustainable forest management
- Forest certification (2008–continuing)
- Forest Industry Challenges of Development and Balanced Use

Emergency phase in forestry

Through FAO after the war in 1999, an emergency phase in forestry project was implemented. The objective was to support Kosovo in establishing government institutions and reorganizing the forestry sector in Kosovo. The other outputs of this project were preparation of a forestry law as well as legislation on hunting. This project supported the drafting of forest policy and strategy, while the hunting strategy has been finalized and approved.

National Forest Inventory

The National Forest Inventory was undertaken during the period 2002–2003, through FAO with Swedish government funding. It provides valuable information on Kosovo's forests in terms of ownership and location, forest type and species, growing stock and increment, treatment required (e.g. thinning), and allowable harvesting levels. The data, although collected six years ago, still represents the most up to date and comprehensive data available for both public and private forests. In past, data at national level was derived from management plans, in the absence of any national forest inventory database. The aim of this project was to establish a regularly updated inventory to be taken every 5 years, but this did not occur, primarily because there was no budget provision for the activity and it was regarded as of low priority. Continuing the national forest inventory will help government institutions and private businesses to know what is happening in the national forests, what potentials for income are and how nature is being protected. Based on a national forest inventory in 1/3 of the forest area in Kosovo, illegal harvesting is a challenge for the country. Inventory would provide updated information about forest protection and health monitoring if it is taken further, as was planned. This inventory for the first time in Kosovo inventoried also private forest areas.

The inventory methodology should be updated to incorporate data showing the effects of climate change, including species distribution, forest vitality, mortality and yield. The inventory permanent sample plots should be regularly evaluated and should be funded through the Kosovo budget or international donor support. This is only way to build a forest information system in Kosovo that will provide data for national and international needs.

Forest Management Planning with GIS

The last forest management plans in Kosovo were produced in 1996 by the Forest Research Institute in Belgrade. After the war, due to numerous legal and illegal activities, the forest situation has changed drastically and most forest management plans have become outdated. There was an urgent need to apply modern methodology for forest management preparation. This new methodology has to incorporate advanced technology beyond inventory, which will help KFA advance use of those plans. Due to limited capacity in Kosovo, there was a need for outside support.

Through support of the Norwegian government, a project "Forest management planning with GIS" was started. There is only one private company in the country with the capacity to produce management plans applying the new methodology. The Ministry every year prepares new management plans (for approximately 8 000 ha) with its own budget, but does not have resources to cover a greater area.

In private forest (some 40% of total forest area in Kosovo) there is a lack of best practices in forest management. There are no management plans for private forest areas and there is an urgent need to support this sector with management best practices.

Management plan methodology is now very modern, incorporating all concepts of sustainable forest management. All data collected and final management plans are available as digital GIS and as hard (printed) copy. In addition to growing stock, all trees cut illegally are estimated and

volume calculated for the last 5 years. Dead standing timber volume is also calculated. The new management planning methodology differs from the old system, which makes it impossible to compare data to assess climate change impact. Areas of high conservation value, water resources and animal habitats are recorded and delineated on the maps.

Sustainable forest management

The main objectives of this project were to:

- introduce forestation at community and household levels to diversify rural farm activity;
- develop commercial forestry management within Kosovo's national parks;
- define areas and zones matching Natura 2000 criteria;
- support the implementation of new legislation on wildlife management and hunting; and
- support the establishment of a silvicultural thinning programme.

This project was supported by EU funds, where the best practices of EU forest management have been introduced. Beyond best practice in forest management, biodiversity and potential for woody biomass have been analysed. The period of this project was short and there is need for continuation of some activities to improve the current situation in the forestry sector and environment. Most components of this project are linked with climate change. The project's terms of reference included afforestation of privately owned, unused or degraded land. In a country which has 42% forest cover (cf. EU average of 34%, Bulgaria 33%, Britain 12% and Ireland 10%), afforestation should perhaps not be given high priority. Additionally, the reduction in traditional grazing has meant that areas are becoming reforested naturally by native trees of local provenance.

It takes at least three years from planning an afforestation programme (year 1: planning, collecting, and treating seed; years 2 and 3: growing the seedlings in the nursery; and years 3 or 4: undertaking afforestation activities). The project was only of 2 years duration, so it was impossible to plan and then grow suitable seedlings in the forest nursery. In the project design there was no budget to allow for purchase of seedlings from outside of Kosovo.

The Indicative Forest Strategy (IFS) prepared by the project identified mainly species for afforestation different from those grown in the KFA forest nursery and Peja. The IFS approach was to identify the right species for planting in the right places. Due to the time lag, the afforestation undertaken by the project had to be done utilizing species available in the nursery in Peja. However, the project still managed to establish the methodology, undertake planting with private land owners, prepare training materials, train participants and to identify the changes in practice and investments required for the nursery.

Since in Kosovo most rural areas are using wood for heating during winter, there is pressure even in the national parks. Several meetings with relevant stakeholders and with institutions responsible for management of protected areas have shown the need to make available a supply of fuelwood for communities living in national parks. The main activities will be within the sustainable use zone. Harvesting operations will be orientated to a mixed species, more natural approach, with selective silviculture treatment to make the forest less susceptible to the effects of wind, snow and pests and diseases, as well as enriching biodiversity in the forest. Through these activities there will be benefit for community through both job creation and fuelwood supply.

The sustainable management forest programme identified a lack of the scientific data and expertise required to identify Natura 2000 sites. Based on existing data sets and research, the project has significantly increased awareness of Natura 2000 in the relevant institutions and with stakeholders. At the same time, a good start has been made with identification of hotspot sites. However, now the hotspot sites have been identified, there are a number of steps that need to be

taken in terms of undertaking the necessary scientific surveys and establishing a nature protection system conforming to international conventions and agreements (e.g. UN Convention on Biological Diversity; the Berne Convention; the EU Birds and Habitat Directives). This will help forest managers to pay particular attention to the sites when they undertake forest operations. The Red List of species needing protection has been identified for Kosovo.

Almost 60% of the forest area in Kosovo is coppice forest, as a result of coppice rotation for fuelwood. The quality and production potential of those forest is not used. They are characterized by dense stands (>10 000 stems/ha). Increment is only 1.3 m³/ha, whereas the soil quality provides the potential for better increment and better quality production. Most activities in this type of forest are pre-commercial thinning, which needs investment. The activities were organized with the adjacent communities. As payment for thinning, the product extracted from the forest was given free to the people. This is a win-win situation: the forests benefit from the silvicultural treatment, and the people benefit from the fuelwood (thereby reducing demand for illegally sourced supplies). More than 100 000 ha of forests needs such thinning activities. Taking into consideration the amount of illegal harvesting, the product extracted can be used to supply the community with fuelwood or for biomass production. Implementation of thinning activities in the rest of the forest area requires both staff and financing.

Thinning of forests will increase tolerance to drought and resistance to wildfire or pests, contribute to *in situ* genetic conservation of species, assist migration of species to suitable habitat, provide wildlife corridors to facilitate animal migration, and contribute to improved hydrology.

The potential of many National Forests to store additional carbon over the short and medium term is limited because many areas have too many small trees, making forests more susceptible to wildfire, pests and disease. Management activities can reduce the number of small trees, allowing the remaining trees to grow larger, improving ecosystem health and reduce the risk of damaging wildfire. Several policies and strategies, such as the Restoration Policy Framework, provide guidelines for managers. However, the management practices designed to restore forests and grasslands and protect communities (through thinning, fuelwood supply, and controlled burning) are likely, at least in the short to medium term, to reduce total carbon stocks below current levels. However, not taking action to improve ecological health will probably result in substantially lower carbon stocks and substantially increased carbon emissions in the future as a result of severe wildfires and losses from pests and disease.

Forest certification (2008 and continuing)

USAID, Kosovo cluster business support project, with its main objective being support to private businesses in Kosovo, found that secondary wood processing in the private sector needs to certify products for export to EU countries. In 2008, the project started initial activities toward forest certification, in close cooperation with MAFRD and KFA. The main activities so far have been training of local Kosovo experts, and organized study tours in countries where forest certification is in place. The working body is established, and this year they were planning to take real action for a pilot area, which can be extended to other forest areas in Kosovo.

Proposed areas for cooperation

List of problems

Based on previous studies and the current situation in forestry, the main challenges are:

- Illegal harvesting operations (of the estimated 1.2 million m³ of possible annual harvesting potential, KFA is taking 250 000 m³ legally, while more than 500 000 m³ are cut illegally).
- Law enforcement, which lags far behind in terms of implementation of the forestry law and other laws in the field of environmental protection.

- Developing a strategy applying EU standards, with participation of local communities, NGOs and other relevant stakeholders. The current draft forest strategy and policy does not involve local communities and their interests are not incorporated.
- There is no strategy for climate change assessment. The government institutions, as the central main power, ignore NGOs and communities. This is obvious when looking at their contribution to the forestry sector and environmental awareness. Until the Government signs the main conventions for nature protection and works actively to decrease pollution in the country, the situation will remain the same or worsen. The initiative to build a new power station has had no environmental impact assessment, and has ignored the complaints of NGOs and communities.
- Kosovo has not signed the Kyoto Protocol, and this should be done as a matter of urgency.
- There is no institution responsible for monitoring GHGs, and advising on protection and reduction of gas emissions.
- There is no available data for gas emission and pollution in the country.
- There is need to adopt a suitable legal framework.
- There is no strategy or action plan for reducing gas emissions.
- Alternative energy applications are noticeable by their absence.

Areas for potential international cooperation

Activities where FAO could contribute to improve the current forestry sector situation are to:

- Help Government institutions (MAFRD, KFA, MoSP), to identify possible donor sources in EU and elsewhere for activities related to climate change.
- Support a national forest inventory, and update methodology through incorporation of attributes for monitoring climate change and its impact on forestry.
- Design a project for carbon sequestration, where special EU funds available could be used to support afforestation of abandoned lands, especially areas that are marginal for agricultural production.
- Help MAFRD develop a better forest strategy and policy with broad participation by stakeholders.
- Develop a strategy for reducing illegal and uncontrolled harvesting activities in forestry.
- Help government institutions to participate fully with countries that have signed the conventions for nature protection.
- Help ministries to participate in international conferences, which will contribute to improving the Kosovo professional environment in terms of knowledge of current proposals and actions in world.
- Identify sources of funding for professionals in Kosovo to take post-graduate studies in EU countries. This could be very helpful for Kosovo if FAO could provide scholarships for one or two PhD students to undertake research into climate change monitoring, which will provide information for Kosovo.
- Establish a coordination body related to climate change, based on the Kyoto Protocol.
- Develop a registry of GHG emissions.
- Develop an assessment of air pollution emissions for 1985–1990, in accordance with the Kyoto Protocol, using IPCC methodology for six economic sectors.

References and source documents

Forestry law.

Final report “Sustainable forest management project”.

Final report “National Forest Inventory Project”.

Strategy for environmental protection kos.rec.org/albanian/pdf/STRATEGJIA%20E%20KOSOV%20P%20P%20CBR%20MJEDISIN.pdf

Kosovo action plan in environment 2006 – 2010 kos.rec.org/new/rec/uploads/files/PKVM.pdf

Report on environmental situation 2006 – 2007. See: www.ks-gov.net/akmm/dokumente/Raporti_Gjendjes_se_Mjedisit.pdf

Report "Kosovo and climate change, problems and challenges for future" Workshop in Prishtina, 28–29 April 2009, organized by UNDP & MoSP

Annexes

Institutional framework and nature protection

The current institutional structures for environmental protection are evolving to meet the particular national circumstances of Kosovo. The ministries and agencies with competency for aspects of environmental protection and management are:

- Ministry of Agriculture Forestry and Rural Development (MAFRD)
- Kosova Forest Agency (KFA)
- Ministry of Environment and Spatial Planning
- Kosova Institute for Nature Protection (KINP)
- Institute for Cultural Heritage Protection

Nature protection areas

Law on Nature conservation (2006/22) Article 16 stipulates that nature conservation means series of measures required for maintaining or restoring the natural habitats and the populations of species of wild fauna and flora at a favourable conservation status. Nature conservation is a strong instrument for protection of nature heritage values and biodiversity. So far, 68 nature sites are protected, and 195 new sites identified for protection. Protected sites cover an area of 46 437 ha (4.25% of Kosovo). There are 1 National Park, 11 nature reserves, 52 nature monuments, 2 protected landscapes and 2 park forests.

Areas proposed for protection

Kosova Institute for Nature Protection (KINP) identified 195 sites of high conservation value in 2000–2005 and proposed that they be protected.

The initiative for establishment of second National Park in Bjeshket e Nemuna was launched in 2003. The proposed area spreads over 60 000 ha and the legal procedure for its establishment is ongoing. If this area gains protected status, the total protected area nationally will extend over 10% of Kosovo.

Protected areas management

The Law on Nature Conservation, Article 17, stipulates that the objectives of protected area management are: (a) scientific research; (b) protection of wildlife, habitats and ecosystems; (c) protection of genetic diversity; (d) protection of environment services; (e) protection of specific characteristics of nature and cultural heritage; (f) tourism and recreation; (g) education and public information; (h) sustainable use of resources; and (i) protection of cultural and traditional features.

The National Park Directorate with its HQ in Prizren manages the ‘Sharri Mountain’ National Park. The ‘Germia’ Regional Park is managed by public enterprise Hortikultura, whereas Gadime Cave is managed by a body that is not supervised by the government. Management of these institutions needs substantial strengthening.

Other reserves, such as Ropsit Peak, Gubavc, Gazimestan, Kozhnjer, Prelep Mountains, and Bifurcation of Nerodime River, Kamilja, and Regional Park Mirusha, have neither managing bodies nor management plans.

“Sharri Mountain” National Park

The national park was established in 1986, and covers 39 000 ha. The Park extends over the municipalities of Prizren (19 500 ha), Shterpce (15 210 ha), Theranda (2 730 ha) and Kaçanik (1 560 ha). The Park is famous for its botanical, faunal, ecological, tourism, recreational and cultural values. Sharri Mountain the habitat of a very important flora, with 86 species declared as important national species, 26 considered as threatened, and 32 included in the Red Book of European threatened species. It can be considered as a centre of diversity in the Balkans and Europe.

KYRGYZ REPUBLIC

Elnura Zholdosheva

Review of the existing information, policies and proposed or implemented climate change measures in Kyrgyzstan

To date, there has been no targeted research on climate change impact on forests and wooded areas of Kyrgyzstan. There has been no study of climate change consequences for forest functions such as productivity, survival ability or loss of plantations, as there is hardly any scientifically-based information on this topic. The only work in this direction was performed within the framework of the National Communications on climate change.

The main problems related to climate change are clear in the country: decreased productivity in agriculture, decreased water supply, increased danger of extreme meteorological events, ecosystem destruction, and increased danger to the health of the population.

Realizing the extreme importance of the climate change issue, the Kyrgyz Republic ratified the UNFCCC in January 2000, and the Kyoto Protocol in January 2003. After the adoption in 2001 of the Law on the Ratification of the Framework Climate Change Convention of the UN, a decree of the Government of the Kyrgyz Republic was adopted “On the Execution Measures of the Framework Climate Change Convention of the UN”.

In accordance with the Decree, the State Agency for the Protection of the Environment and Forestry of the Kyrgyz Republic is the responsible executive organ that implements the obligations of the Kyrgyz Republic under UNFCCC and the Kyoto Protocol. Being a Party to the Convention, Kyrgyzstan periodically submits reports to the Secretariat of the UNFCCC, providing a complete assessment of the modern state of the country in relation to climate change, supplying the following information:

- National condition.
- Inventory of the anthropogenic emissions from sources and GHG absorption by absorbers.
- Base scenarios.
- Vulnerability assessment to climate change, and adaptation measures.
- Measures aimed at climate change impact mitigation.
- Miscellaneous information on reaching the Convention’s objectives.

Having ratified the UNFCCC and the Kyoto Protocol, the Kyrgyz Republic moved to practical actions in the sphere of climate change. Since then, in accordance with the requirements of the international agreements, a number of active measures have been taken in the Republic:

- A detailed survey of sources of GHG emissions for the period 1990–2005 has been completed, i.e. the assessment of the Republic’s impact on climate change has been performed.
- The expected climate changes for all of the Republic’s regions have been prepared for the period to 2100.
- Qualitative assessments of anticipated climate change impact have made in different spheres, such as the condition of surface water resources, the condition of glaciers, biodiversity, forest resources, agriculture, health of the population, and climatic emergencies.
- Measures have been taken to adapt to the expected climate changes and to mitigate climate change impact.

The Second National Climate Change Communication of the Kyrgyz Republic was prepared, and approved by Government Decree No. 274 of 6 May 2009. The vulnerability and adaptation issues of climate change in Kyrgyzstan were outlined. The analysis of the Second National Communication results was successfully presented to the UNFCCC at its session in Bonn in June 2009.

Kyrgyzstan has made an important step in the creation of the regulatory and legal basis for execution of obligations under the UNFCCC. Specialists of the State Agency for Environmental Protection and Forestry of the Kyrgyz Republic together with UNDP experts developed a Law “On State Regulation on the Greenhouse Gases Emission and Absorption Policy”, which was adopted by the national parliament in 2007. This Law creates the necessary legal basis for the implementation of the state climate change policy.

By supporting global ecological efforts on climate change prevention, by Order No. 281 of the President of the Kyrgyz Republic, dated 18 June 2005, the National Committee on Climate Change Consequences (NCCC) was established, and officially registered at the CDM Executive Council at the Secretariat of UNFCCC. In accordance with the requirement of the Executive Council of the CDM, NCCC is led by the manager of the state executive body responsible for the execution of obligations under this convention. The main objective of the NCCC is the coordination of national activities for the execution of the Republic’s obligations under UNFCCC and the Kyoto Protocol.

According to the SNC assessment on climate change, by 2100 there will be practically no glaciers and snowfields, the run-off from which are the main source of water for rivers. This forecast has implications for the condition of water resources in the entire Central Asia region. The results of the studies conducted during the preparation of the First and Second National Commitments showed that over the last century the air temperature on the territory of Kyrgyzstan increased by 0.8°C. This is higher than the average world change of 0.6°C.

Information on forestry-related projects

The study of climate change impact on the forestry of Kyrgyzstan within the framework of the National Communications to UNFCCC resulted in the information on Kyrgyzstan's forest sector considered below.

A short description of Kyrgyzstan’s forest sector

The forests of the Kyrgyz Republic are the property of the Kyrgyz Republic, and, according to the Forest Code, have the status of protected natural areas. The forests form a unified State forest fund that includes both area actually covered by forest as well as the areas that are not covered by forest but designated for forestry needs.

According to the most recent official assessment (1 January 2008) the total acreage of the State forest fund’s lands amounted to 3 533 100 ha, including 932 100 ha covered by forests. Forests cover 4.6% of the Republic’s territory. The combination of vertical zonation and a variety of climatic zones have resulted in considerable diversity in forest-forming species in the forest reserves and have also led to rather low forest coverage of the territory.

Kyrgyzstan is a country with limited forest cover, and the forests are unevenly distributed over the country. They have primarily environmental functions and serve as natural reserves. The forests of the Kyrgyz Republic are dominated by four species: walnut (41 000 ha.), spruce (124 100 ha), juniper (archa tree) (303 500 ha) and inundatable (48 300 ha) forests.

Pistachio and almond plantations grow over the dry piedmonts of the Fergansky range and higher, at an altitude of 1300–1800 m, while over the slopes of Fergansky and Chatkal'sky ridges there spreads a solid mass of walnut forest, located in the Zhalalabad and Oshsky regions. The

Circassian walnut (*Juglans regia* L.) is the most valuable species among the great variety of tree species, and is the dominant species in the walnut forests.

In the northern part of the country, in the Priissykul'ye, Narynsk region over the slopes of the Kyrgyz ridge, the forests are formed predominantly by Tian-shan spruce (*Picea schrenkiana* Fisch. & Mey.). Its total acreage equals 128 200 ha, or 13.8% of the entire forest acreage of the Kyrgyz Republic. The spruce forests are located on the steep slopes of the mountain ranges, where they attenuate erosion processes, stabilize the soil against mud-and-stone landslides, regulate mountain river runoff and direct surface runoff into subsurface runoff.

The juniper (locally called *archa*) forests and the associated dwarf forms are of extreme importance. Archa forests are widespread in the dryer and harsher conditions of the Altai crest, and cover 303 500 ha, or 32.5% of the country's forests. The largest areas of archa forests are concentrated in Oshsky and Batkensky regions on the slopes of the Turkistan and Altai mountain ranges, but it is also found extensively in Zhalalabadsy oblast, in Chatkalsky, Ala-Bukinsky and Aksyjsky regions.

The archa forests are located on steep mountain slopes and they perform important water regulation and water conservation functions, preventing soil erosion and preventing mud- and landslides, which have been the cause of severe disasters and devastation.

The inundatable forests in the mountain regions are located along the bottomland and shores of large rivers: Naryn, Chu, Tyup, Talas, Susamyr, Dzergalan, Yassy and along many small rivers, occupying about 48 300 ha (5.5% of the Republic's forests). Such forests typically have water conservation functions. The natural content of the bottomland forests depends on species adaptiveness to the environmental conditions, and on competition between species. In the mountains, along river shores and on deltas, the vegetation grows in the form of narrow, broken forest strips, which frequently form riparian woods (*tugais*) consisting of black poplar (*Populus nigra*), Asiatic poplar (*Populus diversifolia*), European willow (*Salix alba*), grey poplar (*Salix cinerea*), oleaster (*Elaeagnus angustifolia*), tamarix (*Tamarix laxa*), sea buckthorn (*Hippophae rhamnoides*). Elm (*Ulmus* spp.) and poplar forests grow along the shores of the Talas river.

The combination of various species forms a wide variety of forest ecosystems: with archa and spruce in the highlands, walnut species in the mid-mountain range, and bottomland (*tugai*) species in the low-hill terrains. The archa and spruce forests are the most widespread (about half of the forest acreage). Walnut species occupy about 10% of the forest land. The most widespread tree and shrub vegetation types in the Kyrgyz Republic have a low biomass growth coefficient and this is why the Republic's carbon absorption potential through the expansion of its forest cover is relatively low.

The national forest cover expansion potential as evaluated by experts shows wide potential range. The most realistic assessment is that the Republic's forest cover could expand by up to 8%, which would mean that the additional yearly accumulation of carbon in the forest reserves would be about 784 Gg CO₂, basing the calculations on The IPCC guidelines for the LULUCF sector. The impact of climate factors on fruit-set in the walnut woods and other forests of Kyrgyzstan has not been sufficiently studied. The climate assessment, based on the connection between environmental factors and fruiting, in particular, allows identification of specific prerequisites for increased fruiting and seed set, and for the creation of artificial stands.

Vulnerability assessment of Kyrgyzstan's forests

In the age structure of the Kyrgyz Republic's forests, mature and declining stands prevail. This applies to all the forest areas. The gradual transition trend from one age group to an older group can clearly be observed. However, because of change to the forest acreage and natural forest

renewal, the acreage of young plantations remains stable. It should be noted that at the present time the age structure of the Kyrgyzstan's spruce forests is skewed; mature and declining stands amount to more than 40%. In the next 20 to 25 years, because of forest aging, mature and declining stands age group will occupy more than 50% of the acreage, and tree losses in the spruce forests will increase because of tree die-off.

Spruce forests

During the vulnerability assessment of the spruce forests that occupy the mountain range from 1600 up to 2900 m above the sea level, we have to take into consideration the changes of the temperature and precipitation patterns related to altitudinal change. When considering the spruce forest vertical range, there is significant vegetation distribution and lack of homogeneity. Considerable acreage is taken by steppe, valleys and scrublands. Sometimes this vegetation is secondary and it appeared as the result of forest harvesting, but in the majority of cases those are native vegetation types.

The spruce forests, growing in general on the slopes with northern exposure, are characterized by relatively high moisture content. Spruce is considered a moisture-loving species. Weak trunk cleaning from the spruce's branches creates a cover that lets through very little precipitation. Thus, at 2000–2200 m, as the lack of moisture and significant heat amounts are present, the spruce forests acreage amounts to 5.2% of the total plantation acreage. These altitudes exactly match the forest range with insufficient moisture content. It is quite probable that the spruce forests acreage could be much greater here, but because of forest accessibility it is decreasing because of wood harvesting, livestock grazing, etc.

Thus, if under present conditions the restricting factor for spruce forest growth at low altitudes is insufficient moisture content during the vegetative period, then at higher altitudes it is the winter conditions that affect its growth. As temperature increases, by 2100 this factor will level-off at high altitudes.

Spruce distribution largely depends on moisture levels and it shows that although the spruce is well adapted to aridness, it is still a moisture-loving species. When the temperature increases, the lower boundary of spruce forest will ascend by 150–200 m.

Archa (juniper) forests

The archa (juniper) forests, which were widespread on the plains of Central Asia, are now a narrow, thinned-out band, located on mountain slopes at altitudes from 1200 to 3200 m above sea level. Over the last 25 years, the archa (juniper) forests acreage has diminished by 18% and the rate of degradation has reached 0.8% per year. The acreage of only sparsely closed stands increased by 31% (11 500 ha), and soil erosion is increasing. There is no doubt that avalanches and mud slides in recent years have caused tremendous damage to the national economy, and the decrease in soil water content can be largely explained by the reduction in mountain forests and by their deterioration.

The degradation of the mountain vegetation is accompanied by the progressive aridization of the slopes and overall climate aridization. According to the existing data, over the last 25 years, the desertification border advanced vertically into the mountains by 500 m. A number of southern semi-desert and desert plants have appeared here that previously were unknown. In the opinion of the majority of the researchers, the main reasons for forest degradation are:

- industrial wood harvesting and wildfires in the past;
- intensive and increasing livestock grazing over the entire area;
- population and livestock growth in the mountain regions; and
- increased recreation.

One effect of the increased summer temperatures is that the archa forest ecosystem will gradually move higher, and by 2100 could be 150–200 m higher than present.

Walnut Forests

A forest restoration plan, covering forest restoration and forest development, was developed to take account of the probable global climate warming and the effect on forest growing conditions for each of the walnut forest subsystems. This plan takes into consideration the range from arid lowland up to moist slopes, and assesses cultivating walnut trees as well as other useful species, such as apple, pear, quince, jujube, plum and almond.

Analysis of the bioclimatic potential in the changing climate conditions for the forest ecosystems shows that the considerable increased evaporation in comparison with precipitation results in worsening of the natural humidity regime of the piedmont territory. We can assume that as CO₂ content increases in the atmosphere, the wetter zone borders will shift upwards, in general by 100–200 m, but in certain locations by 400 m.

Thus, if at altitudes of 1400–2300 m in the southwestern region in the well watered area (walnut forests) we see increased bioclimatic productivity, then in the dry steppe and in the semi-desert areas at 800–1400 m, typically with pistachio and almond plantations, this productivity will change little, or may even worsen under the influence of anthropogenic factor. Thus, climate change will contribute to changes in the biodiversity of the Republic; a considerable expansion of desert and steppe zones is anticipated.

Forestry adaptation strategy to the climate change

- Strategy No. 1. Improvement of the legislative basis of the Kyrgyz Republic (Forest Code, the development and the implementation of national adaptation measures to the climate change).
- Strategy No. 2. Implementation of institutional reform in the forest sector (separation of regulatory and management functions).
- Strategy No. 3. Improvement in the forest sector personnel potential (one of the consequences of the ambiguity in relation to the future climate change impacts is the fact that the specialists use past data to design future activities).
- Strategy No. 4. Development of sustainable forest management criteria and indicators.
- Strategy No. 5. Improvement of public awareness.

Review of future tasks and research topics, and lack of knowledge relevant to international activity threats

According to the information stated above, the following threats can be anticipated for the development of Kyrgyzstan's forest sector:

- Climate change will contribute to the altitudinal advance of the desert band's upper border by 400 m, the steppe band will advance by 250 m, the forest and glade band will advance by 150 m and the sub-alpine band will advance by 100 m. This will undoubtedly affect flora biodiversity. Some invertebrates adapted to certain specific soil types will be lost. The loss of some herbivorous animals is expected if certain plants disappear from the ecosystem.
- The range of many plant types and the main forest-forming species will change. Due to the increased soil moisture content requirements, the lower border of the European walnut will rise by 100–150 m, conditioned by the increase in the active temperature sum by 438°C and by the humidity increase and the extension of the growing period by 30 days. In this ecological niche typical of the lower sub-band of the walnut forest, the proportion of drought-resistant bushy types such as rosehip, hawthorn and honeysuckle will change.

Species that can adapt to the increased temperatures (pistachio, almond and jujube) will move up by 100–200 m.

- There will be increased degradation of lands in the vicinity of populated areas, with increased possibility of landslides, caused by excessive livestock grazing on the pastures near the villages.
- Worsening of the survival ability of forest cultures and plantations because of insufficient financing for use in reproduction, protection, prevention of illegal forest harvesting, and fighting pests and diseases.
- Lack of information on climate change impact on the condition of the forests will impede effective planning for forestry development. The current ambiguity in relation to future climate change impacts is the fact that the specialists have to rely on very limited past data to guide future activities.

Climate change projects implemented in Kyrgyzstan's forestry sector

In Kyrgyzstan there is only one climate change project currently being implemented that is directly related to forestry. In 2008, an agreement was signed between the International Development Association, represented by the World Bank, and the Government of the Kyrgyz Republic on a preparatory grant from the Japanese Government for the preparation and implementation of the forest restoration component and forest cultivation in the Kyrgyz Republic “*Tian-Shan Ecosystems Development*”. This project is a continuation of the Central Asian Trans-border project on the preservation of the Western Tian-Shans biodiversity.

Main executor: State Agency on Environment Protection and Forestry under the KR Government

International executive agency: European Bank for Reconstruction and Development (EBRD)

Donor: Global Environmental Facility (GEF), Government of Japan/PHRD

Objective: Contribute to the improvement of ecosystems management and sustainable forestry in project areas in the Kyrgyz Republic. The following are several of the global ecological objectives: preservation of biodiversity; and mitigation of the climate change through greenhouse gases deposits (accumulation and entrapment) in the forests of the Kyrgyz Republic

Expected results: *Within the framework of Component A:* Providing technical assistance and support to the selected specially protected territories, creating management plans for the specially protected territories, and providing technical assistance for the improved monitoring of biodiversity. *Within the framework of Component B:* Forest restoration and forest cultivation in all the regions of the Kyrgyz Republic on the acreage of 13 950 hectares of the State Forest Fund and on the agricultural lands, not used in agriculture (bogged, degraded, salinized, etc).

Activity Component A. The carbon deposition assessment at national level and project design development address project design development and carbon deposits project preparation—the Tian-Shan Ecosystem Development Project (TSEDP)—including the preparation of a feasibility study and the selection of tree planting sites; the preparation of the Project Design Documents according to the Clean Development Mechanism, the base investigation and monitoring plan, as well as assessment of the institutional and legal bases; implementation of pilot measures within the TSEDP framework by the selected communities and by the forest management entities; and carbon deposits assessment at the national level.

Activity Component B. The national potential increased by the creation of a State Agency for Environmental Protection and Forestry Potential for implementation of the land use projects, changes in land use character and in forest management, including increasing potential in relation to the rules and processes of the CDM in general, and of the rules and processes of the BioCarbon Fund in particular; and increasing the forest service potential and village administrations (*ayil oktmotu*) in events coordination dedicated to forest plantation and forest cultivation and carbon deposits with joint forest management and public forest management.

Activity Component C. *Project approval, initial verification, negotiations and monitoring:* Initial TSEDP verification by an independent Authorized Body; Providing legal assistance to the State Agency of the Environmental Protection and Forestry on conducting negotiations on the emissions reduction agreement and on the development of the plan for the village administrations and for forest management entities to receive income; Conducting pilot activities on afforestation.

Activity Component D. *Coordination and management.* Providing support for general management and coordination of measures within the framework of the grant agreement implementation, including preparation and consultations on the work plan, procurement schedule, financial reporting and accounting responsibilities.

Project's contact address: asatybekov@gmail.com

However, in the Kyrgyz Republic there is no single international project, targeted at the study and the assessment of the climate change on forests and plantations of Kyrgyzstan. The list below shows projects related to climate change currently being implemented in Kyrgyzstan, but that are not directly related to forestry.

The UNDP project "Increasing the potential for the implementation of sustainable waste management in the Kyrgyz Republic".

The main executor in the Kyrgyz Republic is the State Agency for Environment Protection and Forestry under the KR Government, and the objective is to assist the Kyrgyz Republic in the implementation of sustainable waste management. The project's objectives are the development of a National Waste Management Strategy, increasing the opportunities for private sector involvement in waste management, increasing public motivation levels in waste management. The implementation of this project will assist in implementation of the four ecological Conventions, ratified by Kyrgyzstan (Orkhuss, Basel, Stockholm Convention, Climate Change Convention). The project's contact address is: office@in.kg or project@in.kg

The project provides assistance to the Kyrgyz Republic in the implementation of separate international Conventions and Agreements, ratified by Kyrgyzstan, in the waste management sphere through their implementation in the legislation of the Kyrgyz Republic, namely

- the development of project proposals to attract resources for the implementation of the provisions of Conventions and Protocols; and
- increasing public awareness and motivation regarding the objectives and the implementation process of the Conventions and their possible contribution to this activity.

GEF/UNDP Project "Demonstrating Sustainable Mountain Pasture Management in the Susamyr Valley, Kyrgyzstan" for implementation under the Convention to Combat Desertification (UNCCD)

The objective is to develop in the Susamyr Valley a cost-effective and replicable pasture management mechanism that reduces the negative effects of livestock grazing on land and which improves rural livelihoods. The main executor in the Kyrgyz Republic is the Ministry of Agriculture, Water Resources and Processing Industry. The project can be contacted at: susamyr@elcat.kg

GEF/UNDP Project "Energy Efficiency in Buildings" for implementation under UNFCCC

The main executor in the Kyrgyz Republic is the State Agency for Architecture and Construction, and the objective is to reduce energy consumption and associated GHG emissions in the Kyrgyzstan building sector by 30–40% compared with the current level. The project can be contacted at e.rodina@up.elcat.kg or e.esykeeva@up.elcat.kg

Expected results are:

- The construction of new buildings, both private and public, to conform with the new energy efficient norms and rules.

- Two pilot schools constructed applying these energy efficiency norms.
- Energy efficiency assessment and GHG emission monitoring of the buildings performed by a certified and appropriately equipped laboratory.
- Introduction of construction education standards, include energy efficiency programmes.

Review of the status of national scientific (research) works on assessment of climate change impact on forest resources

Activities are implemented by the Institute of Forest and Walnut Cultivation of the National Academy of Sciences of the Kyrgyz Republic, which is the only establishment that studies the condition of the forests and conducts bio-ecological studies. However, cooperation between the State Agency for Protection of the Environment and Forestry and the Institute of Forest and Walnut Cultivation is not very pronounced. Various studies have been conducted with the support of various international projects. There has been no targeted research into climate change impact on forests and forest plantations.

Potential future activities

Below is a summary list of proposals for international cooperation with FAO.

- Improvement of the legislative basis of the Kyrgyz Republic.
- Adoption of a strategy for climate change adaptation measures.
- Development and implementation of a national climate change adaptation plan and other regulatory activities.
- Implementation of institutional reform.
- Separation of regulatory and management functions.
- Support to increased productivity of forest resources by improved management. Support to forest preservation measures and forest protection measures.
- Increasing public awareness. Public awareness levels regarding climate change issues are extremely low. No effective public information system has been developed.
- Development of sustainable forest management criteria and indicators.
- Increasing forest resources productivity. For example, at present very little attention is paid to the condition of walnut plantations. Systematic upgrading of the walnut species could deliver greater crop yields. This will provide the local population with more income, while reducing damage to forest plantations.
- Organization of assessment and of payment for the ecological services of the forest, primarily in performing protective functions.

References

- Climate Change and the Required Technologies Assessment. 2004. Bishkek.
- E. Shukurov. 2004. Ecological value of the Kyrgyzstan's forests and the state support for their preservation. Presented at the Regional Forest Congress, Bishkek, 2004.
- Orlov, O.V., Dzhumadylova, C.K., Khudaibergenov, A.D. & Rodni Stuparik. 2003. Climate change and its impact on the forest ecosystems of the Kyrgyz Republic. Bishkek.
- Podrezov, O.A. & Titova, L.I. 2002. The modern climate of Kyrgyzstan and its change scenario in the 21st century. Bishkek.
- Second National Communication of the Kyrgyz Republic under the Framework Climate Change Convention of the UN. 2009. Bishkek.
- Vengelovsky, B.I. 2006. Biological specifics of Kyrgyzstan's walnut forests restoration and development. Bishkek.

THE FORMER YUGOSLAV REPUBLIC OF MACEDONIA

Nikola Nikolov

Summary of climate change dimensions

Acknowledging the significance of the climate change problem and the need to take effective actions for its mitigation, the Republic of Macedonia ratified the UN Framework Convention on Climate Change (UNFCCC) on 4 December 1997 (Official Gazette of Republic of Macedonia – International agreements 61/97), and became a Party to the Convention on 28 April 1998. As a Party to the Convention, the country has produced the First National Communication (FNC) to the Conference of the Parties (CoP).

Macedonia's First National Communication under UNFCCC

The FNC of Macedonia is the very first national report on the country's condition regarding climate change issues, prepared following the guidelines adopted by the Conference of the Parties (CoP) for preparation of national communications by Parties not included in Annex I to the Convention. Preparation of the FNC is seen as an initial step in the actual implementation of the UNFCCC in the country. It allowed development of expertise in each sector involved in the preparation of the FNC, enhancing institutional and technical capacities in these fields and increasing public awareness concerning the UNFCCC and climate change-related issues. The report contains the analyses, results and recommendations of technical experts, prepared by specialist institutions in the country that implemented complex activities in the thematic areas, fully utilizing the resources and results of relevant prior or ongoing national and related international activities. At the same time, the report has served as a basis for future actions.

In that document, the forestry sector is referred to in the chapters on national circumstances; inventory of GHG emissions; GHG abatement analysis and projections of emissions; vulnerability assessment and adaptation measures; national action plan; and research and systematic observation.

The GHG emissions inventory was prepared according to IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 1996), taking into consideration the three main GHGs: carbon dioxide (CO₂), methane (CH₄) and nitrous oxide (N₂O). GHG absorption and emission from the forestry sector are result of two processes: changes in biomass stocks, and conversion of forests to grassland. Based on estimations for 1990, annual CO₂ emissions from the forest sector were 415 Gg, absorption was 820 Gg, with net absorption of 405 Gg.

According to the vulnerability assessment and adaptation measures in the FNC, changes in the forests and forestry have been recorded and predicted. The health condition of the oak and the fir stands, especially the oak, in the last decade of the 20th century showed rapid deterioration. Migration of tree species to regions at higher altitudes could be expected, together with increased wildfires and consequent burnt-over areas.

Forestry should take measures for adaptation and mitigation of the effects of climate change, including:

- Controlling the oak dieback process, as well as for other tree species, with a sanitary cut that could lead to prevention of development of some specific tree diseases and proliferation of harmful pests.
- Increasing significantly the extent of protection of forests from forest fires.
- Afforestation of about 150 000 ha of barren land to increase the forest fund to about 1 150 000 ha, an increase of about 15%.

Biodiversity Strategy and Action Plan

The strategy, as a basic planning document, defines an integrated approach to the conservation and sustainable use of the components of biodiversity, while the action plan encompasses specific activities that must be accomplished in order to achieve the overall aim and guiding objectives enumerated within the strategy.

The issue of climate change, forests and forestry is addressed in the chapter on *Key threats to biodiversity*. Also, in the biodiversity action plan, there are several actions relevant to climate change, forests and forestry, mainly in terms of monitoring of climate change effects in forests, and improvement of forest management in line with climate change and biodiversity.

Second national ecological action plan

This National Environmental Action Plan (NEAP) identifies the national environmental challenges, establishing at the same time the measures, directions and activities required to improve the environment during the next 6 years. The obligation to develop a NEAP derives from the Law on Environment (Official Gazette of RM nos. 53/05 and 81/05).

In the frame of the chapter on *Forest management*, emphasis is placed on forests as a valuable natural resource, and their important role in the process of air, water, soil and biodiversity protection. Amongst others things, forests can serve as global stores of carbon and biodiversity.

There is a list of key *Problems and Priorities with Objectives and Measures*. In the list of planned actions, the most relevant for the issue of climate change are the assessment of potential for GHG abatement through reforestation in respect of CDM project implementation, and the development of strategy for forest fire prevention.

Strategy for sustainable development of forestry

The Republic of Macedonia is a signatory to many international agreements and conventions on forests and environmental protection that influence the forestry sector. The EU orientation of the country implies the necessity for harmonization of forestry policy with EU commitments. The strategy reflects contemporary trends in world forestry. At the same time, it gives methods for solution of the numerous problems in national forestry in correlation with the demands of the sector, as well as with its significance for sustainable development, reflecting the intention of the Republic of Macedonia to become a full member of the EU in the near future. Although the issue of climate change and forestry (from the biological and economic points of view) has received adequate treatment in all parts of the strategy, the key chapter is that on forestry and the environment.

Forest, as the most valuable part of the ecosystem and capable of significantly improving the general quality of life, occupies a special position in the global concept of environmental protection. Besides this, the role of forests in carbon sequestration from the atmosphere should be taken into account in relation to the Kyoto Protocol. Therefore, forests deserve special treatment by an appropriate system of protection, care and usage, with emphasis on sustainable development.

The strategy ensures the maintenance of protective forest functions and increased positive contributions of the forest sector to environmental, water and soil protection; the protection of the populace and infrastructure against natural hazards; local and global GHG emission reduction; etc. In particular, two proposed measures combine forestry and climate change, namely increasing the area under forest and undertaking appropriate silviculture that increases CO₂ sequestration; and encouraging sustainable forest management practices, taking into account the possible implementation of forestry activities under UNFCCC and the Kyoto Protocol.

Re-establishment of plots (Level I) and assessment according to ICP Forest methodology

The first survey at Level I in Macedonia (applying ICP Methodology, on a 16 × 16 km grid) was in 1988, with over 40 plots surveyed. In 1990, that survey was repeated more precisely on a 4 × 4 km grid of plots. With disintegration of Yugoslavia, the plot surveys stopped. There were several attempts for their re-establishment, but without success until 2006. By the initiative of the Forestry Faculty in Skopje (Department for Protection of Forests and Timber), the Ministry of Agriculture, Forestry and Water Economy in 2006 made a decision to re-establish the plots and to conduct the survey on a Level I grid (16 × 16 km) in collaboration with the International Co-operative Programme on Assessment and Monitoring of Air Pollution Effects on Forests (ICP Forests).

Among other objectives, ICP Forests has the objective to contribute by means of monitoring activities to other aspects of relevance for forest policy at national, pan-European and global levels, such as effects of climate changes on forests, sustainable forest management and forest biodiversity. The key findings in terms of crown condition of the trees were that, from a total of 644 trees assessed, 305 (47.4%) showed no signs of defoliation; 162 (25.1%) were in Class 1 (with 10–25% defoliation); 168 (26.1%) were in Class 2 (with 25–60% defoliation) and 9 (1.4%) were in Class 3 (with 60–100% defoliation). No totally dry trees were registered. The assessment also showed 476 trees (73.9%) with no signs of discoloration; 148 (23%) in the first category of discoloration (10–25%); 16 (2.5%) in the second category (25–60%); and 4 (0.6%) were in the third category of discoloration of the crown (>60%).

Crown transparency, along with previous two assessments, gives the whole image of the condition of the tree crown. The conclusion was that 283 trees (43.9%) have no symptoms of crown transparency; 156 (24.2%) were class 1 (10–25%); 194 (30.2%) were class 2 (25–60%); 11 (1.7%) were class 3 (60– <100%); and none of the trees had reached class 4 (100%). These results, together with others from the report, show the condition of the forests in Macedonia in terms of climate change and other factors. It is a basis on which the Ministry of Agriculture, Forestry and Water Economy and the Government of Macedonia can take decisions concerning forests and the forestry sector.

Assessment of the plots (Level I) according to ICP Forest methodology

Following the recent re-establishment of the plots, the second Level I survey was done in 2007. However, 2007 was an extreme year regarding forest fires, with 635 fires recorded, leaving a burnt out area of about 35 000 ha. Because of that, monitoring activities on plots were seriously interrupted. The report of the survey noted:

The process of dieback is practically at the same levels as in 2006. We have identified several groups of causative agents, of which the most important are insects, fungi, abiotic factors, forest fires, human activities and other undetermined factors.

In 2007, forest fire incidence was extremely high, and there have been large areas of damaged or destroyed forests by forest fires. This seriously affected the quality of assessment of the plots. A large number of plots were not assessed, which has had a negative effect on the overall quality of results.

Macedonia's Second National Communication under UNFCCC

As a continuation of the FNC under UNFCCC the Second National Communication (SNC) was prepared. The main goal for GHG inventorying was to prepare national GHG inventories for 1999–2002 (with 2000 as the base year), according to the guidelines for the preparation of National Communications (17/CP.8). The main source of information was the State Statistical Office (official yearbooks), as well as official data from other national institutions, such the Ministry of Agriculture, Forestry, and Water Economy and the Ministry of the Interior.

The forestry sector inventory covers emissions of CO₂, CH₄, N₂O, and CO, using the Tier 1 methodology, both for the re-calculated period within the Initial National Communication, and for the period 1999–2002. No new gases were included. The main problems during this inventory derived from uncertainties in the activity data for the forest area, stock and annual forest growth, changes in land use, as well as loss of biomass due to commercial logging, illegal logging, wood decay in forest and the processing industry. The annual balance of emissions of GHG gases, as well as the percentiles for different gases, for the period 1990–2002, in this sector are shown in Table 1. The highest contribution to GHG gases comes from the subsector Conversion of Forest and Grassland, as well as from the on- and off-site burning of biomass.

Table 1. Contribution of individual GHGs to the total CO₂-eq emissions in the LULUCF sector.

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
[kt]	CO ₂	257.73	21.87	385.30	689.47	248.31	5.15	46.78	161.39	81.01	90.47	1,711.95	291.90	31.65
	CH ₄	14.76	1.25	22.07	39.49	14.22	0.30	2.68	9.24	4.64	5.18	98.05	16.72	1.81
	N ₂ O	1.50	0.13	2.24	4.01	1.44	0.03	0.27	0.94	0.47	0.53	99.51	16.97	1.84
	CO	9.66	0.82	14.45	25.85	9.31	0.19	1.75	6.05	3.04	3.39	64.20	10.95	1.19
	Total	283.66	24.07	424.06	758.82	273.29	5.67	51.49	177.63	89.16	99.57	1973.70	336.53	36.49
[%]	CO ₂	90.86	90.86	90.86	90.86	90.86	90.86	90.86	90.86	90.86	90.86	86.74	86.74	86.74
	CH ₄	5.20	5.20	5.20	5.20	5.20	5.20	5.20	5.20	5.20	5.20	4.97	4.97	4.97
	N ₂ O	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	5.04	5.04	5.04
	CO	3.41	3.41	3.41	3.41	3.41	3.41	3.41	3.41	3.41	3.41	3.25	3.25	3.25
	Total	100.00	100.00	100.00										

Land Use, Land-Use Change and Forestry (LULUCF) is a very important sector for investigation for the overall balance of GHG gases for specific countries and globally, because it is the only sector that absorbs the emissions that are emitted from this and other sectors. The main emissions from this sector come from the annual loss of biomass for commercial harvest, changes in biomass stock, on- and off-site burning of biomass, wood decay, and changes in land use. For the period analysed, this sector absorbs all of its emissions at the national level, except for 2000, because of the enormous number of forest fires, where the balance between absorption and emission is negative.

In line with scenarios for climate change to 2100 year in Macedonia, an assessment was made of climate change impacts on the forestry sector. The possible climate change impacts on the forestry sector are:

- More intensive processes of forest dieback, particularly in the fir and oak belt.
- Increased population of some pests (particularly insects and fungi), because of physiological stress of trees.
- Migration of tree species towards higher altitudes, and change in floristic composition of current forests.
- Increase in number of forest fires and burnt areas.

These impacts will increase expenditure in the forestry sector and are expected to cause significant economic damage. In response, and reflecting the climate change scenarios, the proposed adaptation measures are:

- Forest rehabilitation using the local endemic oak species and other endemic species through introduction of silvicultural and planning measures, improvement of species composition of forests (natural and reforested), using endemic tree species with more resistance to climate change.
- Strengthen preventive measures that improve forest management and minimize the risks of fires.

- Increase monitoring and observation plots in the most vulnerable and economically valued forests. This will enable government and foresters to take a more systematic and longer-term approach towards the most viable (economically and ecologically) and pro-sustainability options for forest management, thus minimizing the occurrence and magnitude of damage from wildfires and pests.
- Development of a good quality database is essential for reconstruction of the Integrated Crop Protection forests network in the country, and is a pre-condition for monitoring of the health national forests, although it will satisfy only part of the real needs.

Establishment of sample plots of certain forests types is the next step in order to monitor all meteorological elements regarding climate change. However, the existing network of meteorological stations in the country is insufficient to monitor climate change influence on forests and forestry, and its modernization and enhancement is essential.

Reforestation is one measure for reclaiming bare lands and cleared areas, usually in oak forests. The domestic oak species the most resistant to climate change are Downy oak (*Quercus pubescens*), Macedonian oak (*Quercus macedonica*) and Kermes oak (*Quercus coccifera*). Other species resistant to climate change are Oriental hornbeam (*Carpinus orientalis*), Manna ash (*Fraxinus ornus*) and Turpentine tree (*Pistacia terebinthus*). In addition to broadleaved species, for forestation domestic coniferous species can be used: *Pinus nigra* and *Juniperus excelsa*.

National Strategy for Sustainable Development of the Republic of Macedonia

The European Partnership, concluded in June 2004, indicates the main priority areas for the Republic of Macedonia's preparations for further integration into the EU, based on the analysis in the Annual Report 2004. The European Partnership also provides guidance for financial assistance to the Republic of Macedonia. The Republic of Macedonia in early 2005 adopted a plan, including timetables and action details, for how the country intends to address the European Partnership priorities. Within the European Partnership, the development of a National Strategy for Sustainable Development (NSSD) ("...in line with the acquis, including a comprehensive plan for the implementation of the recommendations set out in the conclusions of the United Nations World Summit on Sustainable Development in Johannesburg 2002") has been identified as a short-term priority (i.e. for the next 1–2 years). NSSD was adopted in 2008.

NSSD sets a vision, mission and objectives for balanced economic, social and environmental development. By joining the global movement of sustainable development, the Republic of Macedonia needs to provide its citizens with a clear direction and road map for the country's development, as well as to motivate their hope and trust in the future.

The belief that social, economic and environmental goals should be complementary and interdependent throughout the development process lies at the heart of the concept of sustainable development. All Macedonian citizens should understand the sustainable development philosophy, as they have a crucial role in building a sustainable society. In the situation of unfavourable demographic trends in the country, including rapid aging of the population and intense emigration, the sustainable development concept is extremely important for achieving sustainability of the national human capital.

In the frame of the NSSD, the forestry sector is shown as a sector with the potential to create a lot of activities, which will lead toward economic and social prosperity. The issue of climate change has a significant place in the field of forestry and environment.

National Strategy for the Clean Development Mechanism

Preparation of the National Strategy for the CDM was conducted under the auspices of UNDP, in collaboration with the UNDP Regional Programme in Bratislava, the Ministry of Environment and Physical Planning, international and national experts, and other relevant stakeholders.

CDM is defined in Article 12 of the Kyoto Protocol. It allows Annex I Parties to invest in projects that reduce GHG emissions and contribute to sustainable development in non-Annex I countries. CDM is the only flexible mechanism that Macedonia can access under the Kyoto Protocol. The two primary goals of CDM are:

- to assist Annex I countries in reaching their emission reduction targets; and
- to contribute to sustainable development in non-Annex I countries (developing countries and some transition economies in southeastern Europe and CIS).

The goal of the National Strategy for the CDM is to facilitate transfer of investment and technologies through CDM for implementation of projects that reduce GHG emissions and contribute to Macedonia's national sustainable development priorities. This strategy outlines a course of actions that the Government of Macedonia, together with its national and international partners, will pursue during the first commitment period of the Kyoto Protocol (2008–2012) to achieve this goal. *Inter alia*, one of the priority areas identified in this Strategy for implementation of CDM projects in 2008–2012 is the forestry sector.

Forests are the most significant natural resource in the system of maintenance, restoration and promotion of primary natural resources (water, soil and air). According to the Physical Plan of Macedonia, forests, forest crops and intensive plantations occupy an area of 934 128 ha (36.7% of the total national area). Net absorption of CO₂ by Macedonian forests is estimated to be in the range of 2.2 Mt CO₂-eq/yr. However, the level of CO₂ absorption can be significantly ameliorated: almost 71% of the nominal forest area is currently occupied by scrub and degraded forests. Activities leading to reforestation of degraded forest areas are technically eligible to be registered under CDM mechanisms and generate CERs in the amount corresponding to the increase in GHG sinks in re-forested areas.

However, CDM rules impose certain limitations on Afforestation/Reforestation (A/R) activities, which have tended to reduce their attractiveness relative to other CDM projects. There is also a lack of approved CDM methodologies for this category and, furthermore, A/R projects sequester carbon over long periods and often take 10 years or more before they generate significant volumes of CERs, which makes them economically less attractive than normal CDM projects, such as landfill gas (LFG) or biogas) that have a quicker pay-back period and higher returns.

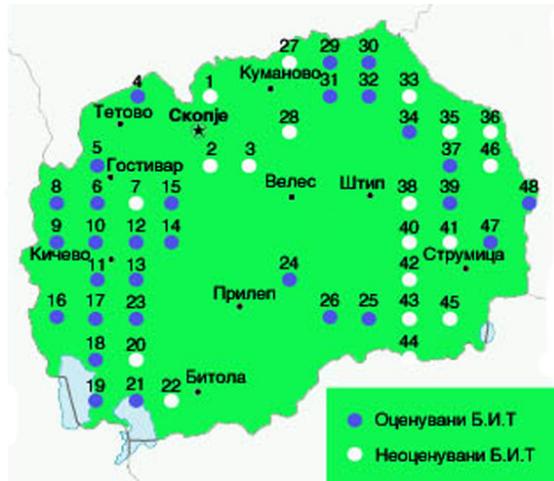
Status of assessment and research on climate change

Research activities and programmes on climate change

The basic research institution for forestry and climate change is the Faculty of Forestry in Skopje. It is a state facility. In its almost seventy years of existence, many researchers have worked, directly or indirectly, on climate or climate change in different forestry sectors.

Within the Department for Forest and Wood Protection, research areas include ecoclimatology; the influence of abiotic factors (climate) on the health condition of the forest and assessment of damage (biological and economic) caused by them; and forest fires, which are related to climate change. This department, on behalf of the Ministry of Agriculture, Forestry and Water Economy of the Republic of Macedonia, is responsible for ICP Forest (data collection, analysis and preparation of an annual report) (Figure 1). Other departments of the faculty which could work on climate change issues are the departments for Forest management and for Silviculture.

Figure 1. Network of the Level I permanent plots (16 × 16 km).



Systematic climate observations

The main institution responsible for systematic hydrometeorological and climate observations in Macedonia is the Hydrometeorological Service of the Ministry of Agriculture, Forestry and Water Economy. Hydrometeorological activities have long and rich tradition in the country. Meteorological measurements and observations started in early 1891, and an organized hydrometeorological station network has existed since 1923. Until 1947, from time to time there were interruptions in measurements and observations, depending on the circumstances. That year, the Hydrometeorological Service of the National Republic of Macedonia was established and a new hydrometeorological network was formed. Today the Hydrometeorological Service has 236 employees, of which 63 with university education. In recent years the scope of the Hydrometeorological Service has extended beyond classic observing of weather, climate and water and their forecasting. It is impossible to imagine national social and economic development without the information that this institution provides for solving the problems in the fields of climate change, water resources management, phenomena mitigation and environmental degradation. At present there are 14 main, 18 climatological and 2 special stations (Figure 2) available in the country, with an additional 122 precipitation stations and 31 phenological observation points.



Figure 2. Meteorological monitoring network in Macedonia.

Macedonia as a sovereign and independent state has been a member of the World Meteorological Organization since 1993, which is a Specialized Agency of the United Nations. Membership in this organization created new possibilities and prospects for development of international cooperation in the fields of meteorology, hydrology and environmental monitoring through participation in the work of congresses, working bodies, commissions and working groups at regional and global levels. Therefore the Hydrometeorological Service, as the agency responsible for hydrometeorological monitoring activity in the country, functions as the National Meteorological Centre. The Service carrying out and co-ordinating international obligations with its research and development programme has participated in numerous national and international projects (MED-HYCOS, EMEP, MEDSEEME-PEP, etc.), it has signed bilateral and multilateral agreements and coordinated with international hydrometeorological and other institutions (UNDP, UNESCO, FAO, ICSU, PHARE, JICA, World Bank, etc.). Its scope of activities is very comprehensive:

- to organize a net of meteorological stations throughout Macedonia;
- to conduct measurements and data collection;
- data analysis;
- data distribution to all stakeholders and institutions; and
- to lead or participate in research projects (domestic and international) in collaboration with similar institutions internationally.

Proposed areas for cooperation

Establishment of permanent plots for monitoring and assessment of the climate change dimensions and impacts of forest and forestry

The influence and consequences of climate change on the forests and forestry in Macedonia are noted in many documents. That was one of the reasons for re-establishments of the IPC Forests Level I plots. Also, the regular activities and many projects of the Department of Forest and Wood Protection address this issue. However, although it provides basic information and knowledge about climate change and forests, it is insufficient to understand the impact of climate change on forestry in Macedonia.

Taking into consideration that vulnerability assessment is crucial for measures of mitigation and adaptation, it is more than obvious that the Macedonian forestry sector needs more precise knowledge on this issue. In order to allow the forestry sector in Macedonia to create sustainable forestry in an age of climate change, permanent plots should be established for monitoring and assessment of climate change dimensions and impacts on and of forests and forestry. Reflecting the tree species composition of the Macedonian forests, it would focus initially on the oak and beech forests. The need for this kind of project has been emphasized many times and in many documents. Expected outputs of this project would be:

- permanent monitoring of forests and climate;
- impact assessed of climate change on forests and forestry;
- measures defined for mitigation of the impacts of climate change on forests and forestry and measures for adaptation; and
- forest management adapted in agreement with predicted future climate change.

Study for climate change, forest fires and forestry

Forest fires are highly sensitive to weather and climate. Under current climate change projections, fire frequency and severity can be expected to increase significantly in parts of Macedonia. The economic losses caused by forest fires in Macedonia in the last 10 years are estimated to be about € 50 million. There is no precise evaluation of ecological losses in the same period. In addition, forest fires release carbon from organic matter into the atmosphere. Estimation of GHG emissions

was prepared according to the IPCC Guidelines for National GHG Inventories (IPCC, 1996) in the frame of FNC and SNC to UNFCCC, including emissions from forest fires. Despite all this, there remain considerable gaps in understanding of the connections between forest fires, climate change, forestry, GHG emission from forest fires, etc. In particular, there is need for a well organized campaign to raise public awareness of this topic. In particular the project could cover:

- determination of the relation between climate change and forest fires;
- impact assessment of the fires of forest and forestry;
- ensuring the data can identify land use changes;
- improvement of the quality of the GHG inventory related to forestry; and
- developing well organized campaigns for public awareness raising.

References and other sources used

Assessment of the plots (LEVEL I) according to ICP Forest's methodology. Contact address: nnikolov@sf.ukim.edu.mk

Biodiversity strategy and Action plan of the Republic of Macedonia. Available at: catsg.org/balkanlynx/05_wildlifemanagement/5_4_biodiversity/Pdfs/DarrellSmith_2003_Biodiversity_strategy_action_plan_FYR_Macedonia.pdf

Faculty of Forestry. Available at web site: www.sf.ukim.edu.mk

Hydrometeorological Service Available at web site: www.meteo.gov.mk

Macedonian's under the UNFCCC. Available at: www.unfccc.org.mk/natcom.htm

Macedonian's Second National Communication under The UNFCCC. Available at: www.moep.gov.mk/WBStorage/Files/Second%20NEAP

National Strategy for Clean Development Mechanism. Available at: www.unfccc.org.mk/default.asp

National Strategy for Sustainable Development of the Republic of Macedonia. Available at: www.nssd.com.mk

Re-establishment of plots (LEVEL I) and Assessment according to ICP Forest's methodology. Contact address: nnikolov@sf.ukim.edu.mk

Second national ecological action plan. Available at: www.moep.gov.mk/default-mk.asp?ItemID=9E22271B4A8D5C4E870435B21B9B87BF

Strategy for Sustainable Development of Forestry in the Republic of Macedonia. Available at: www.mzsv.gov.mk

MOLDOVA

Pavel Gavrilita and Ala Druta

Summary of climate change dimensions

The Republic of Moldova signed the UNFCCC on 12 June 1992 and the Parliament ratified it on 16 March 1995, thus officially recognizing the significance of the climate change-related problems for humanity. The Kyoto Protocol was ratified by Moldova on 13 February 2003 (the official date of accession was 22 April 2003).

Climate conditions and their dynamics

Moldova's climate is moderately continental, characterized by relatively mild winters with little snow, long warm summers and low humidity. The country is located in an area where the air masses coming from the Atlantic Ocean via Western Europe interact and mix with the air from the extreme continental northeastern regions and the Mediterranean air from the southwest. Two distinctive patterns are observed with regard to territorial distribution of the climatic features in Moldova: a distinct zoning of annual rainfall, showing a decreasing trend from north to south; and an increase of approximately 100 mm/yr in the multi-annual rainfall averages in the upland regions, depending on the neighbouring flatland areas. The average annual air temperatures vary between 6.5°C (1987) in the north and 12.3°C (2007) in the south (Table 1).

The observation records of the past 20 years show the average monthly air temperatures varying between -8.5°C in January (1996) and +26.0°C in August (1992). The warm period of the year is approximately 190 days long. The annual precipitation intensity decreases from the northwest to southeast. During 1985–2007 the annual rainfall averages varied between 451 mm (2000) and 891 mm (1998) in the northern part of Moldova and 307 mm (2003) and 813 mm (1997) in the south of the country. The annual total number of rainy days (with >0.1 mm of rainfall) varied between 121 (1986) and 174 (1987) in the northern regions and between 91 (2003) and 152 days (1991) in the southern regions.

Historical data indicate that Moldova has a highly variable climate that has already experienced an increase in mean temperature, moisture deficits and extreme events, like drought, floods and frosts. Moldova copes with climate change risks through adaptation measures including development of policies and investments to enhance natural resource management and increase research, development and extension activities (e.g. appropriate land use, conservation agriculture, improved water use efficiency and sustainable forest and pasture management).

As of 1 January 2008, forestry ecosystems were represented 456 200 ha of forestland and other forestry vegetation, or 13.5% of the national land resources. The forestry resources comprise the forestry fund and forest vegetation on lands not belonging to the forestry fund (84.1%) but owned by the state, the rest belonging to the local public authorities (15.7%) and private owners (0.2%).

Table 1. Average annual air temperature and precipitation reported at the stations of Briceni (north), Chisinau (centre) and Cahul (south) in Moldova, 1985–2007.

Period	Average annual air temperature (°C)			Average annual precipitation (mm)		
	Briceni	Chisinau	Cahul	Chisinau	Briceni	Cahul
1985–1989	7.5	9.1	9.3	629.4	539.6	495.6
1990–1994	8.7	10.3	10.3	531.4	477.2	461.8
1995–1999	8.1	10.0	9.8	697.2	634.0	615.0
2000–2004	9.1	10.5	10.8	574.6	541.8	457.4
2005–2007	9.1	10.9	11.3	700.3	560.7	465.7

Forests play an extremely important role in catchment protection, and provide a number of direct and indirect economic and environmental benefits to rural communities in terms of fuelwood, non-wood products, ravine stabilization, landscape beautification and other benefits. A long-term, one-hundred-year trend of deforestation has been reversed in the past 50 years, and Moldova's current forest policy calls for a further increase in forest cover through forestation and improved community management of forests for direct uses and catchment protection.

Fuelwood is particularly important for rural households, who are unable to afford gas or electricity for heating and cooking. These benefits belie the fact that the forestry sector contributed just 0.3–0.4% of GDP during the last decade. The total value of forestry products and services, as estimated by the Forestry Research Institute for 2007, was MDL 57.7 million. Despite afforestation activities conducted from 2002 to 2008, the country still has a very low level of forest cover, which explains in part the frequency and severity of soil erosion, flood and landslide events.

Forestry Sector general policy

The forestry policy of the Republic of Moldova focuses on biodiversity conservation at all levels, training of staff in the forestry sector, harmonization of the legislative framework, and international cooperation. The legislative framework underlying the state policy in the forestry sector comprises: Law No. 1515-XII of 16.06.1993 on Environment Protection (1993); Forest Code (Parliament Resolution No. 887-XII of 26.06.1996); the Law on Reclamation of Degraded Land via Planting of new Forests (Parliament Resolution No. 1041-XIV of 15.06.2000); Sustainable Development Strategy for the Forestry Sector (Parliament Resolution No. 350-XV of 12.07.2001); National Strategy and Action Plan on Biodiversity Conservation (Parliament Resolution No. 112-XV of 27.04.2001); Government Resolution No. 636 of 26.05.2003 on Approval of the Programme for Land Use and Soil Fertility Improvement (2003); Government Resolution No. 737 of 17.06.2003 on Approval of the State Programme for Reclamation and Planting of new Forests on the Land Available for Forestry for 2003–2020; Government Resolution No. 739 of 17.06.2003 on Implementation of the Sustainable Development Strategy for the National Forestry Sector; together with other Laws and Government Resolutions applicable directly or indirectly to the sector. The successful implementation of this legislation will contribute to the achievement of new qualitative and quantitative targets in the forestry sector, thus increasing its input in the solution of the ecological and socio-economic problems.

Current situation in the forest sector

Consolidation of the bio-productivity and eco-productivity capacities of the existing forests

The consolidation of the eco-protective and bio-productive potential in existing forests requires the prevention of their further degradation, as well as conservation, regeneration and reconstruction of the forest ecosystems by switching from a grove mode to a *Codru* (forest) mode, with broader application of mass regeneration treatments and prompt replacement of low productivity plantations. In 1997–2005, such work was performed on an area of about 33 000 ha (Table 2).

Forest conservation

The contribution of the forestry sector to the national economy takes the form of forest products (wood and non-wood) supplied as finished or semi-finished products, or raw material, as well as services. Around 300 000 to 400 000 m³ of fuelwood are gathered annually on average as result of forest maintenance and work to ensure plantation continuity in the forest resources managed by the Forestry Agency “Moldsilva”, including fuelwood, which accounts for about 85%. Raw wood is harvested in the forests managed by Moldsilva during the cutting of secondary products (evolution treatments; cleaning; thinning; cleaning cuttings, including selective sanitation treatments), cutting of principal products (regeneration, conservation, clean sanitation cuttings) and ecological reconstruction.

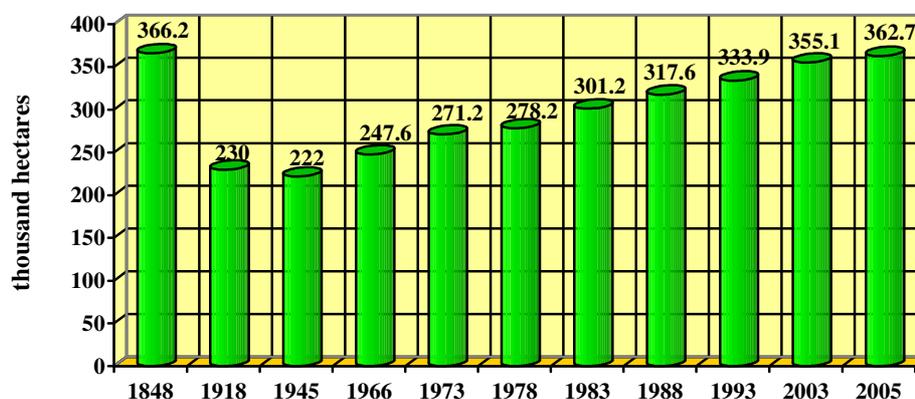
Table 2. Forest areas (ha) covered by ecological regeneration and reconstruction activities

Years	Forest regeneration			
	Total	Forest Plantation	Support to natural regeneration	Ecological reconstruction
1997	5040	1011	4029	0
1998	3989	1152	2837	0
1999	3065	1030	2035	169
2000	3309	816	2493	74
2001	2809	953	1856	77
2002	3643	1219	2424	455
2003	3050	998	2052	375
2004	3171	977	2194	393
2005	2944	981	1963	381

The worst situation is in the forests and other forest-type plantations managed by the local authorities, where, due to the needs of the local residents for fuelwood for heating and cooking, and for construction timber, illegal logging totalled about 104 000 m³ in 1997–2005. In that period, the average illegal felling per 1000 ha of forests and forest-type plantations managed by Moldsilva were about 12 m³, whereas it was about 30 m³ (2.4-fold) in the forests managed by the local authorities. It should be noted, furthermore, that a part of illegal logging, in particular in the forests managed by the local authorities, remains undetected and therefore is not recorded. Starting in 1999, the situation has been returning to normal, showing a definite decrease in the extent of illegal logging, including in the forests of the local authorities.

Expansion of the forest area

In the context of implementing the national programmes and strategies in the sector within the 1999–2005 period, efforts were made in Moldova to expand the area under forests, by adding 30 119 ha of degraded agricultural land to the national forest reserve. To ensure forest restoration and expansion of the areas under forest-type plantations in the 1999–2005 period, the forestry facilities produced about 280 million seedlings. From 2005 to 2009, the area covered by forest changed little. To ensure constant ecological balance and more pronounced impact on the local climate and hydrology, to establish ecological corridors connecting forest areas and to improve the productivity of agricultural land, it is expected to plant forests on about 128 000 ha by 2020, with about 5 000 ha of plantations with quick-growing species and about 5 000 ha of green zones in urban and rural settlements.

Figure 1. Evolution of forested areas in Moldova, 1848–2005.

Risk factors conditioning forest vulnerability

The ecosystems within the limits of the forestry fund are characterized by a wide diversity, comprising 28 distinct ecosystems and a series of biogeocenotic sub-types (by productivity). The ecosystems include major forests of oak (*Quercus* spp.), durmast (*Quercus petraea*) and beech; water meadows; and mixed species woods. The forestry ecosystems have 123 associations, of which over 25 phytocenotic taxons are regarded as standard phytocenoses. Currently almost all forestry ecosystems are affected by human impact, expressed as destroyed biotopes, unregulated harvesting of biological resources or inappropriate ecosystem management. The ecosystems of small and relatively small forest vegetation bodies are affected structurally and functionally to a larger extent, as their biotopes are usually degraded and to a large extent occupied by arborescent (*Acer negundo*), scrubby (*Sambucus* spp.) and herbaceous (Urticaceae, Lamiaceae, Apiaceae, Brassicaceae) invasive species. The national forestry fund also includes rare types of ecosystems, such as beech woods and petrophyte ecosystems of oak and durmast woods, unique in terms of biodiversity.

The woods are predominantly composed of deciduous species (97.8%), including oaks (*Quercus* spp.) (143 800 ha; 39.6%), ash (*Fraxinus* spp.) (16 600 ha; 4.6%), hornbeams (*Carpinus* spp.) (9 400 ha; 2.6%), acacias (*Robinia* spp.) (131 000 ha; 36.1%), and poplars (*Populus* spp.) (5 700 ha; 1.6%). Resinous species (mainly *Pinus* spp.) are present in small proportion, as little as 2.1%.

The standing stock of oak species is the most valuable wood in the national forestry fund. The woods originate 27% from seeds and 73% from offshoots. The big share of oak species originating from offshoots is one of the consequences of a grove mode management of these species over centuries. Such a distribution has an impact on oak productivity, with 43% of high productivity and 57% of low productivity. Almost one-third of the standing stock creating the forestry fund represents artificially introduced species not well adjusted to the natural ecosystems of the country.

In recent years the area occupied by woods grew, with considerable growth in the share of acacias and resinous species. The total surface occupied by oak species increased by circa 20 000 ha, although their share in the total structure of woods fell by 14.3%. The forestry ecosystems consist of circa 860 species, which account for 43% of the total spontaneous floral biodiversity of the Republic of Moldova.

In the forest ecological communities, almost 60% of the vertebrate and invertebrate species are common. It is significant that more than half of all the vegetative and animal species included in the Red Book of the Republic of Moldova are in forest biotopes. Given the overall characteristics of the forest vegetation, it is necessary to mention the big share of acacia and other introduced species (38.7%). The existing five thousand woodland areas, with areal extents ranging from 5 ha to 15 000 ha) are dispersed and in effect isolated. There are none of the interconnecting forest corridors that are of major importance both for the viability of the forestry fund and for maintaining biological diversity, conserving soils and providing hydrologic protection. Development of forestry ecosystems and associations depend on climate, geomorphology, pedology and other conditions. Most vegetal associations include durmast standing stock (52 associations), English oak (*Quercus robur*) (26 associations), and pubescent oak (*Quercus pubescens*) (6 flora associations).

Table 3. Features and impacts of the major risk factors determining the vulnerability of forest ecosystems.

Risk Factor	Nature of Damage
Low level of forestation on the country's territory.	Low potential to maintain constant ecological balance.
High dispersion and uneven distribution of forest bodies.	Reduced interconnection capacity between forestry cenoses determined by insufficient communication networks. Spatial isolation and reduced spectrum of ecosystem component variability.
Use of second to fourth generation shoots in vegetative propagation of 60% of trees in the forests (in durmast, this share reaches circa 90%).	Impact with more serious consequences for biotic and abiotic factors.
Low level of fruiting that does not assure sexual regeneration of oak species.	Reduced genetic variability of forest populations which in their turn determine the low resistance of the latter to unfavourable biotic and abiotic factors.
Highly degraded standing stock of natural and introduced species, which also compete with indigenous species.	Acute competition between indigenous and introduced species with gradual elimination of indigenous species and invasion of the introduced species.
Extended areas with accelerated and high rate of drying. High risk of diseases and pests.	Degradation determined by damage caused by diseases and pests.

Monitoring of forest phytosanitary condition

In 1992, the Republic of Moldova launched a number of monitoring activities related to the health status of the forests, establishing 12 constant surveys within the European system "IST Forest" for forest monitoring, and 680 surveys within the national system. The objectives of health monitoring is to collect information regarding vegetation health and forestry soils, the effects of forest pollution, the size and structure of the production fund in relation to establishment and development of managerial measures, and mitigation and prevention of negative situations in Moldova.

Moldova's forests are characterized as highly vulnerable to pests and diseases. Pest problems include damage caused by defoliating pest, including *Tortrix viridana* L., *Limantria dispar* L., *Erannis defoliaria* Cl., *Operophtera brumata* L., *Stereonychus fraxini* Deg., *Neurotoma nemoralis* L. and *Diprion pini* L.

There is also a detrimental impact on forest structure due to xylophagus pests, including *Agrilus biguttatus* F., *Cerambyx cerdo* L., *Plagionotus detritus* L., *P. arcuatus* L., *Scolitus intricatus* Rat., *Xiphydria longicollis* Geoffr., *Hylesinus fraxini* Panz. and *H. crenatus* F. The effect of climate changes on forest yield, vitality decline, mortality and plant physiological response to climate change factors will be the subject of future investigations, as currently we lack the data.

Potential impact of climate change on forest ecosystems

Natural forests in the Republic of Moldova are a well preserved component of the landscape, which however greatly depends on climate factors. Current dominant mesophilic beech, durmast and oak forests reflect two climatic factors: temperature and precipitation. The climate change impact on forest ecosystems was assessed using several models (CSIRO-Mk2, HadCM2 and ECHAM4) and some trends identified.

- Evolution in time of the phytosanitary condition of forests according to CSIRO-Mk2 and HadCM2 models. This forest characteristic will change dramatically, highly affecting forests in the northern part of the country, as they will dry out extensively. The same may occur

with the forest species in the southern and central parts of the country, in particular in the eastern part of the central zone, because the stands mostly originate from the shoots of multiple generations and will be subjected to the serious phenomenon of mass drying out by 2099. According to the ECHAM4 model climate scenario, the current ecosystem drying phenomenon will be much stronger; by the end of this century climate aridization in the northern part of the country will result in particularly serious drying effects, with possible gradual disappearance of forests.

- Case study based on evolution in time of introduced species, acacia groves and ash tree monoculture. According to the climate scenarios in CSIRO-Mk2 and HadCM2, by the end of this century, while the ECHAM4 scenario predicts the middle of this century, these species may find themselves in adverse growth conditions, which may lead to substantial decrease in volume growth, the occurrence of disease and pest hotspots, and mass drying of soils. Such a situation can be prevented only through complex and costly works of ecological reconstruction aimed at introducing sub-level species to prevent the situation.
- Mathematical simulation of forest ecosystem evolution based on climate change. To assess impact on forests, the JABOWA III dynamic model describing the evolution of species composition and productivity depending on local conditions, species features and climate elements, was used, and established that the difference between biomass accumulation scenarios increases with the age of the trees. In the mix of species, the hornbeam and ash may be the most vulnerable species in the new climatic conditions determined by climate change. In the first half of the production cycle, starting 2010, the ash tree may display 20–40% decrease in biomass growth, while in the second half both species may feature much less growth than under the baseline scenario, which does not account for climate change.

National efforts to build up national capacity to address climate change issues have been widely supported by the international community through a series of international projects, summarized below.

Moldova Soil Conservation Project (www.icas.com.md/index.files/PDSFC.htm), 2002–2022.

Project brief description: The afforestation and reforestation activities of the CDM project cover all districts of the Republic of Moldova (over 20 289.91 ha of degraded land), excluding the eastern territories of Transnistria.

Project output: The total GHG emission reduction is estimated as 3 215 296 t CO₂-eq., and the reduction costs as USD 13.340 million compared with the baseline.

Moldova Community Forestry Development Project (www.icas.com.md/index.files/PDPC.htm) 2006–2035

Partners: World Bank BioCarbon Fund, Forestry Research and Management Institute, State Forest Agency.

Project description: The project's development objective is to restore degraded land to economic and environmental use for the benefit of rural communities. In addition to community benefits, the project's forestation activities should support, through restored productivity and conservation of soil, the global objectives of carbon sequestration and reduction of atmospheric GHG concentrations.

Community Forest Development Project (2004–2007)

Partners: Japanese Government, Policy and Human Resource Development Grant (PHRD), Moldsilva, State Forest Agency of Moldova, ICAS.

Project brief description: The project was oriented to development of forests and pastures. The project contributed toward building capacity and improving the enabling environment for community forest management by providing technical assistance for the development of community forest management capacity; and direct technical support to communities for creating new forests and protective forest belts.

Project output: New community forests and protective forest belts were established on an area of 8157 ha.

Feasibility Study of Biomass Fuelled DH Pilot Plant in RM (2005–2006)

Partners: Swedish International Development Cooperation Agency

Project brief description: The main objective of the feasibility study was to elaborate a more detailed analysis of the biomass-fuelled DH Pilot Project proposed in a previous pre-study and to confirm the opportunity to introduce wood fuels as a complement to other fuels in the Moldovan district heating sector.

Project output: Feasibility Study Report

National Strategy of Natural Hazards Mitigation and Climate Change

Partners: The World Bank, NGO-Business Consulting Institute

Project output: Documented in final report.

National Human Development Report 2009

UNDP supported the Socio-Economic Impact of Climate Change in Moldova and Policy Options to Adapt. (www.undp.md/publications/2009NHDR/NHDR_eng_full.pdf)

Technology and information transfer: improving capability to fight defoliating insects in the Republic of Moldova

In 1999, the Republic of Moldova faced an extensive outbreak of several species of defoliating moth infesting the country's sparse forest resources. With FAO TCP support, entomologists from the Forest Service of the United States Department of Agriculture provided in-country technical assistance in the design and implementation of aerial application projects. The project was part of a series of similar projects covering Bulgaria, Mongolia, Romania and the Former Yugoslav Republic of Macedonia. (www.fao.org/docrep/007/y5507e/y5507e07.htm)

Status of assessment and research on climate change

With reference to forest ecosystems, the most relevant adaptation measures to new climate conditions are associated with:

Revision of Sector Policies

- Revision of the Forestry Sector Sustainable Development Strategy and of the Action Plan in the context of adjustment to new socio-economic realities.
- Development of local programmes on the use, conservation and development of natural resources (forests, other types of forest vegetation, grasslands), establishing community-level ecological networks taking into account the geographical, pedoecological features, the relief, etc., including the prevention or mitigation of natural hazards.
- Development of plans on planting forest vegetation on lands managed by other entities than the Moldosilva (70 000 ha).
- Development and implementation of projects aimed at planting protective forestry strips on 12 100 ha for agricultural land protection, on 28 000 ha for erosion control, and on 14 900 ha for water conservation.

Applying a single forestry regime in managing forestry resources and forest vegetation, regardless of ownership

- Implementing forestry landscaping on the entire territory covered by forestry resources and forest vegetation managed by local public administrations, accounting for all forestry resources.
- Development of a National Landscaping System, taking into account the concrete conditions of the Republic of Moldova.

- Strengthening of community forests to improve their condition, guarding, protection, regeneration and use, as well as to assure their wider specific poly-functionality.

Conservation and quantitative and qualitative development of forests and other types of vegetation

- Expanding the area covered by forests by 7 500 ha annually (potentially to up to 20% of the national territory) on degraded land, privately owned land, etc.
- Expansion of the grassland area by 3 900 ha annually (potentially to up to 22% of the national territory) on agricultural land affected by erosion or on slopes greater than 70%.
- Development and implementation of a national programme of ecological reconstruction of the standing stock that does not correspond to current conditions, providing for reconstruction of circa 1 900 ha annually.
- Planting 20 000 ha of energy forests to satisfy the needs of the population for fuelwood.
- Carrying out surveys to assess the real consumption of wood products, including from illegal logging, developing and submitting periodic reports (2009 and 2013) on consumption of wood products.

Revision of the legal framework

- Development of the new version of the Forestry Code (to include some new chapters such as the communal and private sector in forestry; forestry taxes, including taxes for activities leading to fragmentation of the forestry fund through road construction, electric power lines or gas pipelines crossing forests).
- Development of a new version of the Environment Protection Law.
- Strengthening the provisions of the Code of Administrative Contraventions and Penal Code regarding protection of forests against destructive actions.

Revision of the regulatory framework

- Revision and development of new, important components of forestry regulation to be integral parts of the forestry regime, focusing on maintenance and conservation of forest areas; conservation of forest genetic resources; ecological reconstruction of forests; and certification of forests, forest products and management systems.
- Development of a new version of the regulation on the manner of maintaining the state record of forestry resources and the state forestry cadastre.
- Development of a new version of the regulation on classification of forests by groups, sub-groups and functional categories.
- Revision of the regulatory framework pertaining to development of an appropriate financial mechanism in conservation and development of forestry resources, by imposing mandatory allocations from some extra-budgetary funds (ecology, roads, etc.) and taxes (ecological tax on imported oil products, for landscaping, etc.) needed for expansion of forested lands.
- Development and approval of the regulation on the principles and way of funding priority forestry activities, on the state's contribution to priority forestry activities (landscaping, research, regeneration and expansion, guarding and protection of forests).
- Development and approval of regulations on environmental values and payment for their beneficiaries (agricultural land owners, treatment facilities, etc.), as well as establishing an economic infrastructure and a wood products market.
- Development and approval of regulations on implementation and assuring functionality of the principles of participatory management of public forest resources.
- Development and approval of a regulation on a wide promotion of pastoral forestry and agroforestry practices, to unify the efforts of the forestry, livestock husbandry and pastoral sectors, mitigating social conflicts.

- Approval and implementation by mayors of local regulations pertaining to forest vegetation and grassland management, including signing agreements between the livestock sector and mayors of contracts for grazing of animals on communal grasslands, specifying the obligations of the parties in terms of grassland maintenance.

Improvement of the institutional framework

- Adequate adjustment of the new conditions of the central forestry authority structure, with effects on the capacities to collaborate and cooperate with other central authorities, local public administrations at all levels, and local communities.
- Establishment by the Forest Research and Management Institute of an agency vested with functions to provide advisory and accounting services to public and private owners of forests and woody areas.
- Establishment of regional and local structures (initially self-financing) responsible for organization and management of forests and woody areas owned by local public authorities and private individuals (communal and inter-communal wood farms), as well as provision of primary technical and logistical support.
- Primary equipping of the Forestry Agency Moldsilva and its territorial structures with modern information technology;
- Procurement of licensed software for developing mapping materials, databases for the forestry sector, accounting and economic reports.

Intensification of international cooperation and investment climate improvement

- Signing and assuring implementation of international collaboration and technical-scientific and production cooperation agreements in the forestry sector.
- Launching technical assistance projects in the forestry sector, including with external donor support, including from international bodies such as GEF, World Bank and EU.

Organization of training, education and professional development activities

- Modernization of the forestry educational institutions, including equipping them with modern equipment and technical facilities.
- Organization of training and re-training programmes for forestry professionals in information technologies.
- Development and implementation of training programmes for owners (initially the staff involved in management, guarding and protection) of communal and private forests and other types of woody vegetation;
- Publication of training and information materials for the forestry sector.
- Strengthening the communication capacity of the state forestry bodies in view of setting up a sustainable social partnership with local communities through local public authorities.

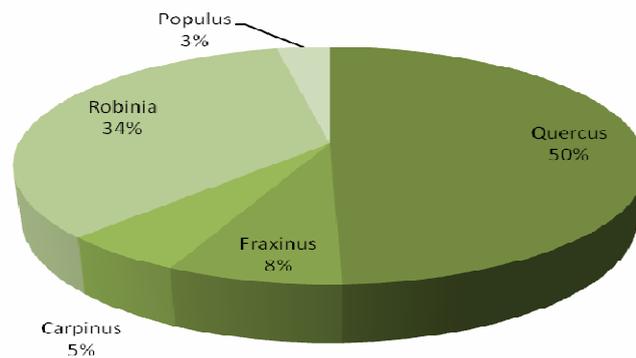
Mobilization of scientific potential and encouraging implementation of innovation in practice

- Development of methodologies and technologies for assuring adaptability of forest ecosystems to climate change.
- Description of natural forest ecosystems in view of adequate execution of forestry works and assessing degrees of vulnerability.
- Development of a general information system for the forestry sector of the Republic of Moldova.
- Development of software for forest inventory and forest cadastre purposes.

Mitigation actions

The forestry sector is considered one of the most efficient in terms of GHG sequestration, accounting for 69% of the total. Due to their biological and productivity peculiarities and areas occupied, forestry species in the national forestry fund make variable contributions to GHG sequestration. Figure 2 indicates the relative importance of the main species, the major one being *Quercus* spp. The significance of the forestry sector in GHG sequestration is constantly increasing through expanding forest area, along with increased productivity from reconstruction and replacement of poor productivity species with more efficient ones.

Figure 2. Forest species contribution to GHG sequestration in the Republic of Moldova.



Measures to increase CO₂ sequestration capacities in the forestry sector include:

- Speeding up expansion of areas covered by forests and other types of woody vegetation on public and private lands.
- Implementing a new phase of expanding forested areas to eroded lands, and planting energy forests, etc.).
- Maintaining wood mass harvesting from silvicultural treatments at the current level, respecting the provisions of effective legislation.
- Decreasing offtake from illegal activities.
- Ecological rehabilitation of forest stands.
- Based on some models of climate evolution in the first half of the 21st century, a slight increase in forest productivity is possible (up to 10%), which will also result in an increased CO₂ sequestration.
- Significant expansion of forested areas in the context of more active promotion of agroforestry and pastoral forestry practices, improving grasslands by planting groups of trees and shrubs, and delimitation of external boundaries and internal plots of the grasslands by planting forest belts.
- Implementing grassland improvement and revitalization activities, increasing the current capacity of 0.6–1.2 t of constant mass per hectare up to 4–5 t/ha.
- Expansion of grasslands onto agricultural lands affected by erosion.

Research

Scientific research plays an important role in the sustainable development of the national forestry sector. Fundamental and applied research is needed to solve urgent problems faced by the forestry-oriented researchers. Applied research is focused on the development of clean and environmentally friendly forest management technologies allowing restoration of forest productivity, structure and functions in compliance with their potential, ensuring improved forest resistance to external negative impacts. The Forestry Research and Management Institute have performed certain activities in that context, including:

- Research on the natural regeneration peculiarities of the plantations affected by natural calamities.
- Research into plantation conditions and their productivity depending on applied silviculture work.
- Research into biodiversity changes in state-protected natural reserves as part of the national system of protected wildlife areas.
- Selection and characterization the valuable pubescent oak plantations.
- Research to identification of appropriate ages for oak trees silvicultural interventions.
- Studying current seed production, with measures recommended to improve the situation.
- Development of recommendations and regulations on seed production and gene pool conservation, ecological rehabilitation of plantations, etc.

Table 4. Status and work by the national Institute of Silviculture Research and Management on research for assessment of effects of climate change.

Project title	Research areas 2006–2010	Research supervisor
Geobotanical research: studies of flora diversity in forest ecosystems in protected areas (joint research with Botanical Garden).	Identification of forestry zones, description of forest types and forest associations, evaluation of biological productivity of forests and their ecological peculiarities.	Acad. Andrei Negru
Forest monitoring.	During 1993–2005, a monitoring process regarding forest health conditions was performed and a database created.	Dionisie Boaghie
Forestry protection and studies of influence of chemical treatments in fighting forest plant pests (common research with Institute of Zoology).	Studies of defoliation pest distribution and their multiplication intensity depending on climatic conditions.	Dionisie Boaghie
Applied silviculture research	Application-oriented research toward improved forest management through justified scientific recommendations regarding maintenance cutting, progressive and consequent silvicultural treatments, developed planting techniques for tree plants and their maintenance, species combinations in forests belts, restoration of damaged wooded areas, management of <i>Acer</i> spp. forests, developing forestry techniques for eroded plots, developing techniques for planting of deep dormancy seeds, stimulation of natural regeneration of oak (<i>Quercus</i> spp.), and use of chemical substances for fighting diseases and pests in forests and nurseries.	

Proposed areas for cooperation

Threats due to climate change

- Species behaviour and their adaptability capacity to new conditions.
- Changes in the distribution and composition of habitats due to changes in species composition.
- Increased number of exotic species in existing natural habitats, with the risk of becoming invasive and leading to extinction of native species.
- Change in wetland ecosystems due to increased aridization.
- Loss of flora and fauna due to species reduced adaptability capacities under new climate conditions, particularly drying effects.

Measures to be taken

- Establishment of a national system for monitoring of threatened species.
- Development of a specific management plan to prevent the progressive degradation of habitats as a result of climate change effects.
- Conduct studies and assess the vulnerability of various ecosystems and species to climate change impact.
- Conduct scientific research on monitoring and forecasting changes in forest ecosystems.
- Review the regulatory framework for forestry regimes.
- Identify and plant species that will benefit from the new environmental conditions.
- Increase forest area through forestation of degraded lands.
- Promotion of efficient agriculture and creation of protective forest belts for agricultural fields and water courses.

Potential project

Conservation and development of forest biodiversity in Moldova. The aim of the project is to improve forest biodiversity, contribute to land degradation recovery and carbon sequestration, that could be achieved through:

- Providing assistance for regeneration and increasing the productivity of native forest in Moldova (species composition and structure).
- Extension of land covered with forests and forest vegetation.
- Increase tree and shrub species diversity and establish a genebank.
- Development of special data regarding forest biodiversity and creation of new protected forest areas.
- Building institutional capacity and public awareness.

Annex 1. International projects addressing climate change issues in the Republic of Moldova

Republic of Moldova: Enabling Activities for the Preparation of the First National Communication under the United Nations Framework Climate Change Convention: 1998-2000.

Partners: Ministry of Environment and Territory Development, UNDP Moldova, GEF.

Project brief description: The Project outlined a number of measures in the most important areas while showing directions for future work and creating a basis for efficient partnership.

Project output: The First National Communication (FNC) of the Republic of Moldova under UNFCCC (unfccc.int/resource/docs/natc/moldnc2.pdf)

Climate Change: Enabling Activities (Phase II): 2000-2002

Partners: Ministry of Environment, Construction and Territory Development, UNDP Moldova, GEF.

Project brief description: The objectives were to identify and assess technology needs for the replacement of old energy-inefficient technologies used in the energy and agricultural processing industries; to assess the possibilities of using renewable energy resources; to build capacity for absorption, design, evaluation and hosting of projects; and to perform an awareness building campaign on climate change issues.

Project output: Enhancement of the general awareness and knowledge of UNFCCC in the country; building national capacity to take responsibility for climate change-related issues (including the technology transfer process); delivering a report on “Technology Needs and Development Priorities” and a “Renewable Energy” Feasibility Study. (www.undp.md/publications/doc/Report_new_1.pdf)

“Moldova: National Capacity Needs Self Assessment for Global Environmental Management”: 2003–2005

Partners: Ministry of Environment and Natural Resources of RM, UNDP Moldova, GEF.

Project brief description: The main goals were to connect the spheres of biodiversity, climate change and combating land degradation; identify and present capacity strengthening needs in each individual area, and for them all in aggregate; national-level approval of the capacity strengthening measures in those three areas in accordance with the national strategies for environment protection, conservation of natural resources and sustainable development.

Project output: Report “Environmental Management: Report on National Capacity Self-Assessment” (nca.undp.org/docs/598.pdf); and “Action Plan for capacity building to implement the Rio de Janeiro Conventions for 2006-2010 period”.

”Capacity Building for Improving the Quality of Greenhouse Gas Inventories (Europe/CIS region)”: 2003–2006

Partners: Ministry of Environment and Natural Resources of RM and National Authorities from other 11 countries from Central European and CIS region, UNDP Moldova, GEF.

Project brief description: The project initiated a regional programmatic approach developed to build capacity for improving the quality of data inputs to national GHG inventories, using the good practice guidance of the IPCC for cost-effectiveness.

Project output: Reduced uncertainties and improved quality of inventories for subsequent National Communications; and improved national strategies for reducing GHG emissions.

“Technical Assistance to Armenia, Azerbaijan, Georgia and Moldova in the fulfilment of their global climate change engagements” 2004–2006

Partners: Ministry of Environment of Moldova, Azerbaijan, Georgia and EU TACIS.

Project brief description: The key objectives of the project included capacity building in the beneficiary countries for the implementation of CDM Projects under the Kyoto Protocol,

including assistance in building the institutional infrastructure to support CDM projects and development of the portfolio of possible CDM projects; raising awareness among key decision-makers, business community and broad public of the country's obligations under UNFCCC and the Kyoto Protocol.

Project output: Portfolio of CDM projects, developed capacity building to mitigate GHG emissions, trained public administration authorities and in key national economic sectors for CDM project development. Four CDM projects have been under implementation in Moldova, and about ten CDM project ideas were still in the pipeline at the development and promotion stage.

“Financing Energy Efficiency Investments for Climate Change Mitigation” 2008–2012

Partners: United Nations Economic Commission for Europe, Climate Change Office, Ministry of Environment of the RM and National Authorities from 11 other countries of the region.

Project brief description: it focuses on funding of investments in energy efficiency activities to mitigate climate change effects in twelve countries of southeastern and eastern Europe and Central Asia.

“Moldova Biomass Heating in Rural Communities (Project Design Documents nos. 1 and 2) 2006–2016

Partners: Carbon Finance Unit Moldova, International Bank for Reconstruction and Development (IBRD) as the Trustee of the Community Development Carbon Fund.

Project brief description: The goal is to generate added value to the Moldova Social Investment Fund (SIF) II Project, through gained GHG emission reduction benefits, directed towards SIF project participants, thus creating incentives for further implementation of GHG mitigation measures.

Project output: Two CDM projects bundle 134 project activities focused on fuel switching activities and energy efficiency in public buildings (schools, pre-schools, public offices, medical centres, etc.). Estimated GHG emission reduction is 357 768 t CO₂-eq.

“Moldova Energy Conservation and Greenhouse Gases Emission Reduction” 2006–2016

Partners: Carbon Finance Unit Moldova, International Bank for Reconstruction and Development (IBRD) as the Trustee of the Community Development Carbon Fund.

Project brief description: The goal of the present project is to generate an added value to Moldova Energy II Project, through gained GHG emissions reduction benefits, directed towards energy project participants, thus creating incentives for further implementation of GHG mitigation measures.

Project output: The CDM project bundles 19 project activities focused on fuel switching activities in public buildings (schools, pre-schools, public offices, medical centres, etc.). Estimated emission reduction is 114 469 t CO₂-eq.

“Renewable Energy from Agricultural Wastes” 2005–2008

Partners: Consolidated Agricultural Project Management Unit (CAPMU) under the Ministry of Environment and Natural Resources of Moldova, GEF.

Project brief description: The ultimate project goal was to lay down the foundations for large-scale efficient use of biomass (straw), which should replace imported fossil fuel and trigger the introduction and promotion of use of primary agricultural waste (biomass) for generation of heat based on efficient technologies.

Project output: 11 biomass boilers (80 kW to 600 kW) with a total capacity of 2720 kW were supplied and installed in public buildings (schools and kindergartens) in rural communities.

“Republic of Moldova: Enabling Activities for the Preparation of the Second National Communication under the UNFCCC” 2005–2009

Partners: Ministry of Environment and Natural Resources of Moldova, UNEP and GEF.

Project brief description: This project led to the preparation of the Second National Communication (SNC) including a national inventory of anthropogenic emissions by sources and removal by sinks of all GHGs not controlled by the Montreal Protocol for the period 1990–2005, and a general description of steps envisaged to implement the Convention, including the development of the National Action Plan on Adaptation to Climate Change and the National Climate Change Mitigation Strategy.

Project output: To be published soon.

Annex 2. Main publications related to climate change

- Academy of Science of Moldova. 2008. Report on the Activity of the Supreme Council for Science and Technology Development and the Main Scientific Results Achieved in Science and Innovation in 2007. Chisinau, 2008.
- Andrieș, S. *et al.* 2004. Programul complex de valorificare a terenurilor degradate și sporirea fertilității solului. Chișinău, Pontos, 212 p.
- Averin, I. 1960. Some changes in composition of hunting fauna of Moldova during last centuries. Journal “Ohrana prirodi”, Nr.1, Publisher “Cartea moldoveneasca”, Chisinau, pp. 125-134. (in Russian).
- Banaru, A. 2000. Methodological Guidelines to Calculate CO₂ Emissions from Arable Soils. Collection of articles “Climate Change, Research, Solutions”, Chisinau, 2000. (in Romanian)
- Banaru, A. 2001. Evolution of Humus Balance in the Soils of Moldova. National Complex Program on Enhancing Soil Fertility. Chisinau, p.83. (in Romanian)
- Boaghie, D. 2005. Reconstrucția ecologică a pădurilor. Chișinău, Centrul editorial al UASM, 275 Buletin de monitoring ecopedologic. 2000. Ediția VII, Chișinău.
- Capcelea, A. 1996. The Republic of Moldova on the way to the sustainable development. Carbon Fond. World Bank. – Ch. Centre Ed. Of UASM. (in Romanian).
- Daradur, M., Cazac, V., Mihailescu, C. & Boian, I. 2007. Climatic Monitoring and Droughts. State Hydrometeorological Service the Republic of Moldova, Institute of Ecology and Geography, Academy of Science of Moldova. - Chisinau, 2007 (Publishing House “Tanavius” SRL.) - 184 p.
- Doniță, N. 1998. Ecologie generală și forestieră. Ed. Ceres, București, 121 p.
- Forestry Agency “Moldsilva”. 1997. National Report with regard to the state of forestry fond of the Republic of Moldova. Chisinau. 48 p.
- Forestry Agency „Moldsilva”, Andrieș S. 1999. Humus and Nitrogen in Moldovan Soils, Optimization and Conservation Measures. Proceedings of the Scientific Conference “Soil Science in the Republic of Moldova at the end of the Second Millennium”. Chisinau, 1999, p. 62–77. (in Romanian)
- Forestry Agency “Moldsilva”. 2003. International Scientific Conference “Sustainable Development of forestry sector of the Republic of Moldova”. Chisinau. 328 p.
- Forestry Agency “Moldsilva”. Various dates. Statistical record reports for the period 1990–2005.
- Forestry Agency “Moldsilva”, Prototype “Epigraf”. Development of community forests, Chisinau. 272 pp.
- Galupa, D., Talmaci, I. & Spitoc, L. 2005. Guide for project management „Soil Conservation in Moldova”. Chisinau, ASUM Publishing Centre, 206 p.
- Galupa, D., Talmaci, I. & Spitoc, L. 2005. Study for the Republic of Moldova “Ensuring Forests and Livelihoods Sustainability by Improving Governance and Illegal Logging Control”. Chisinau, ASUM Publishing Centre, 116 p.

- Galupa, D., Talmaci, I. & Spitoc, L. 2006. Forestry Sector of the Republic of Moldova – Issues, Accomplishments, Perspectives. Chisinau, ASUM Publishing Centre, 27 p.
- Galupa, D., Talmaci, I. & Spitoc, L. 2008. Moldova Community Forestry Development Project Carbon Sequestration and Emission Reductions Study. Chişinău, ICAS.
- Galupa, D., Talmaci, I. & Spitoc, L. 2008. Moldova Community Forestry Development Project Baseline Study. Chişinău, ICAS.
- Galupa, D., Talmaci, I. & ŞSpitoc, L. 2008. Agro-forestry practices in Moldova and Climate Change. Chisinau, IEP Stinta, 96 p.
- Galupa, D., Talmaci, I., Spitoc, L., Rotaru, P., Rusu, A. & Boaghie, D. 2006. Forests and Public Grasslands Development in the Republic of Moldova. Chisinau, ASUM Publishing Centre, 19 p.
- Gulca, V. & Herbst, P. 2005. Moldawien: Nachhaltige Waldbewirtschaftung schafft IPCC (1997), Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories Vol 1-3.
- Kapp, G., Horst, A., Galupa, D., Talmaci, I., Spitoc, L., Horn, L., von Velsen-Zerweck, M., Grigoriev, P. & Danii, T. 2003. Moldova Soil Conservation Project carbon Sequestration and Emission Reductions Study. GFA Terra Systems.
- Kapp, G., Horst, A., Galupa, D., Talmaci, I., Spitoc, L., Horn, L., von Velsen-Zerweck, M., Grigoriev, P. & Danii, T. 2003. Moldova Soil Conservation Baseline Study. GFA Terra Systems.
- Kravciuc, I. 1966. Carefully to behave with forests in Moldova. - Journal “Ohrana prirodi”, Nr.4; Publisher: “Cartea moldoveneasca”, Chisinau, pp. 58-68. (in Russian)..
- Ministry of Ecology and Territorial Development/UNDP Moldova. 2000. First National Communication of the Republic of Moldova, Submission to the UNFCCC COP-6 on 13th of November 2000.
- Ministry of Ecology, Construction and Territory Development/UNDP Moldova. 2002. Technological Needs and Development Priorities. Report developed under the UNFCCC. Chisinau: Cartdidact, 2002 (“Reclama” Printing House). 176 p.
- Ministry of Environment and Natural Resources/National Institute of Ecology of the Republic of Moldova State of the Environment Reports 2002, 2003, 2004, 2005, 2006 (National Reports). Chisinau, “Mediul Ambiant” (Environment), 2003, 2004, 2005, 2006, 2007.
- Ministry of Environment and Natural Resources/UNDP Moldova. 2005. Environmental Management: Report on National Capacity Self-Assessment. Cartdidact, 2005 (“Reclama” Printing House). 152 p.
- Ministry of Environment and Natural Resources. 2007. Environment Protection in the Republic of Moldova, Chisinau. 64 p.
- National strategy and plan for actions in the field of conservation of biologic diversity. Nr.112-XV, April 27; Publisher: “Stiinta”, Chisinau. 108 pp. (in Romanian).
- Official Monitor of the RM No. 10 as of 01.10.1993, Parliament of the Republic of Moldova, Law No. 1515 as of 16.06.1993 on Environment Protection.
- Official Monitor of the RM No. 23 as of 27.04.1995, Parliament of the Republic of Moldova, Resolution No. 404 as of 16.03.1995 on Ratification of the UNFCCC.
- Official Monitor of the RM No. 9 as of 15.01.2002, Parliament of the Republic of Moldova, Resolution No. 605 as of 02.11.2001 on Approval of the Concept of the Environmental Policy of the RM.
- Official Monitor of the RM No. 048 as of 18.03.2003, Parliament of the Republic of Moldova, Law No. 29 as of 13.02.2003 on Accession of the Republic of Moldova to the Kyoto Protocol of the UNFCCC.

Official Monitor of the RM No. 6 as of 01.01.2004, Resolution of the Government of the RM No. 1574 as of 26.12.2003 on Assigning National Commission for Implementation of Provisions of the UNFCCC, as well as Mechanisms and Provisions of Kyoto Protocol.

Official Monitor of the RM No. 019 as of 30.01.2004, Parliament of the Republic of Moldova, Resolution No. 566 as of 25.12.2003 on Approval of Research and Development Strategic Priorities for the period 2004-2010.

Official Monitor of the RM No. 43-46 as of 30.03.2007, Resolution of the Government of the RM No. 304 as of 17.03.2007 on Approval of the Ecological Security National Program for the period 2007-2015.

Official Monitor of the RM No. 127-130 as of 17.08.2007, Parliament of the Republic of Moldova, Law No. 160 as of 12.07.2007 on Renewable Energy.

Official Monitor of the RM No. 141-145 as of 07.09.2007, Resolution of the Government of the RM No. 958 as of 21.08.2007 on Energy Strategy of the Republic of Moldova until year 2020.

Official Monitor of the RM No. 65 as of 25.12.1991, the Parliament of the Republic of Moldova Law No. 828 as of 25.12.1991 the Land Code.

Official Monitor of the RM No. 6 as of 30.06.1993, Parliament of the Republic of Moldova, Resolution No.1546 as of 23.06.1993 on accession of the Republic of Moldova to some environmental conventions and ratification of the Convention on Biological Diversity.

Official Monitor of the RM No. 77 as of 28.11.1996, Parliament of the Republic of Moldova, Law No. 915 as of 11.07.1996 on Plant Varieties Protection.

Official Monitor of the RM No. 4 as of 16.01.1997, Parliament of the Republic of Moldova, Law No. 887 as of 21.06.1996 on Forestry Code.

Official Monitor of the RM No. 40 as of 19.06.1997, Parliament of the Republic of Moldova, Law No. 1102 as of 06.02.1997 on Natural Resources.

Official Monitor of the RM No. 92. . 66-68 as of 16.07.1998, Parliament of the Republic of Moldova, Law No.1538 as of 25.02.1998 on the Natural Areas Protected by the State.

Official Monitor of the RM No. 003 as of 14.01.1999, Parliament of the Republic of Moldova, Resolution No. 257 as of 24.12.1998 on Accession of the Republic of Moldova to Convention to Combat Desertification in Drought/Desertification Affected Countries.

Official Monitor of the RM No. 133-134 as of 02.12.1999, Parliament of the Republic of Moldova, Law No. 612 as of 01.10.1999 on Plant Protection.

Official Monitor of the RM No. 116 as of 09.11.2000, Parliament of the Republic of Moldova, Law No.1041 as of 15.06.2000 on Improving the Degraded Lands through Afforestation

Official Monitor of the RM No. 46-49 as of 27.04.2000, Resolution of the Government of the RM No. 367 as of 13.04.2000 on Approval of the National Program to Combat Desertification.

Official Monitor of the RM No. 090 as of 02.08.2001, Parliament of the Republic of Moldova, Resolution No.112 as of 27.04.2001 on Approval of the National Strategy and Action Plan on Biologic Diversity Conservation.

Official Monitor of the RM No. 133 as of 08.11.2001, Parliament of the Republic of Moldova, Resolution No. 350 as of 12.07.2001 on adopting the Strategy for Sustainable Development of the Forestry Sector of the Republic of Moldova.

Official Monitor of the RM No. 099 as of 06.06.2003, Resolution of the Government of the RM No. 636 as of 26.05.2003 on Approval of the Program on Use of New Lands and Enhancing Soil Fertility.

Official Monitor of the RM No. 126 as of 27.06.2003, Resolution of the Government of the RM No. 739 as of 17.06.2003 on Implementation of the National Strategy for Sustainable Development of the Forestry Sector.

- Official Monitor of the RM No. 132 as of 01.07.2003, Resolution of the Government of the RM No. 737 as of 17.06.2003 on Approval of the State Program on Regeneration and Afforestation of Forestland for the period 2003-2020.
- Official Monitor of the RM No. 142 as of 08.09.2006, Resolution of the Government of the RM No. 1007 as of 01.09.2006 on the Progress of the State Program of Regeneration and Afforestation of Forestlands for the Period 2003-2020, Approved by the Government Resolution No. 737 as of June 17, 2003.
- Popusoi, A. 2002. Report concerning to state of forestry sector from Moldova, in the reference period 1997–2002. Presented in the Conference “Sustainable development of forestry sector in the Republic of Moldova”, 23 November. (in Romanian).
- Postolache, G. 1995. Vegetation of Republic of Moldova. “Editura stiintifica”, Chisinau. (in Romanian)
- Proca V.E., și col. 1981. Prognoz vozmojnâh izmenenii v prirodnoi srede pod vlianiem hoziaistvennoi deiatelnosti na territorii Moldavscoi S. S. R., Ed. Știința, Chișinău.
- Șabanova, G. A., Bulat, A. & Tofan, E. 2005. Raport privind diversitatea floristică și fitocenotică a păturii erbacee pe sectoarele din cadrul proiectului „Conservarea solurilor în Moldova”. Chișinău, ICAS.
- Șabanova G.A., Izverscaia T. & Ghendov V. 2007, 2008. Raport privind diversitatea floristică și fitocenotică a păturii erbacee pe sectoarele din cadrul proiectului „Conservarea solurilor în Moldova”. Chișinău, ICAS.
- Talmaci, I., Țăranu, M. & Scorpan, V. 2008. Emisii/sechestrări de GES în cadrul sectorului „Utilizarea terenurilor, schimbări în utilizarea terenurilor și gospodăria silvică” în Republica Moldova în perioada 1990-2005. Chișinău, Revista „Mediul Ambiant”, nr. 2 (38): 42–46.
- Tkacenco, A. 1961. From the past of the forest of Moldova. - Journal “Ohrana prirodi”, Nr.5;
- Țurcan, V. 2005, 2007. Raport privind diversitatea avifaunistică pe sectoarele din cadrul proiectului „Conservarea solurilor în Moldova”. Chișinău, ICAS.
- Țurcan, V. 2008. Raport privind diversitatea avifaunistică pe sectoarele din cadrul proiectului „Dezvoltarea sectorului forestier comunal în Moldova”. Chișinău, ICAS.
- Ursu, A. 2000. Degradation of Soils and Desertification. Chisinau. 307 p.
- Ungureanu, V.T. *et al.* 1997. Ways to Control and Create a Positive Humus Balance in Soils in Moldova, Chisinau, p. 47 (in Russian)
- Uspenskii, G. 1970. Ways to create the optimal complex of fauna in the cultural landscape of Moldova. Bulletin of Academy of Sciences of Moldova. Biological, chemical and agricultural sciences, Nr. 2, Publisher “Cartea moldoveneasca”, Chisinau, pp. 52-58.
- Vdovii, G. *et al.* 1997. Report on the forest fund’s status of the Republic of Moldova. - Chisinau. 48 pp.
- Zagorcea K.L. 1990. Optimization of Fertilization Systems in Crop Rotation. Chisinau, p.286 (in Russian)
- Украинское лесоустроительное предприятие, (1987), Сводный проект организации и развития лесного хозяйства, лесных предприятий Министерства лесного хозяйства Молдавской ССР. Том 1, Ирпень.
- Швиденко А.З., Савич Ю.Н. (1987), Нормативно-справочные материалы для таксации лесов Украины и Молдавии. Киев. «Урожай», стр. 162, 216, 232, 273, 320.

Annex 3. Forestry sector activities based on the Republic of Moldova Action Plan for 2009–2013

Sector Policies

Revision of Sector Policies of the Forestry Sector Sustainable Development Strategy and of the Action Plan in the context of adjustment to new socio-economic realities	2009–2013
Development of Local Programmes on the Use, Conservation and Development of Natural Resources (forests, other types of forest vegetation, grasslands), establishing community-level ecological networks taking into account geographical, pedo-ecological features, topography, etc., including in the context of prevention or mitigation of natural hazards	2009–2013
Development of a National Landscaping System, taking into account the actual conditions of the Republic of Moldova	2009–2013
Strengthening of community forests to improve their condition, guarding, protection, regeneration and use, as well as to assure their wider specific poly-functionality	2009–2013
Development and implementation of the national programme of ecological rehabilitation of the standing stock which does not correspond to stationary conditions, providing for restoration of circa 1900 ha annually	2009–2013
Carrying out surveys to assess the real consumption of wood products, including from illegal logging, and developing and submitting periodic reports (2009 and 2013) on consumption of wood products	2009–2013

Legal, Regulatory and Institutional Framework

Development of a new version of the Forestry Code (to include some new chapters on communal and private sectors in forestry; forestry taxes, including taxes for activities leading to fragmentation of the forestry fund through road construction, marking out electric lines, gas pipelines crossing forests, etc.)	2009
Revision and development of new, important components of the forestry regulatory basis, as integral parts of the forestry regime, focusing on the following areas: maintenance and conservation of forestry stations; conservation of forestry genetic resources; ecological reconstruction of forests; certification of forests, forest products and management systems	2009–2010
Development of a new version of the Regulation on the manner of keeping the state record of the forestry resources and the state forestry cadastre	2009–2010
Development of a new version of the Regulation on classification of forests by groups, sub-groups and functional categories	2009–2010
Revision of the regulatory framework pertaining to development of an appropriate financial mechanism in conservation and development of forestry resources, by imposing mandatory allocations from some extra-budgetary funds (ecological, roads, etc.) and taxes (ecological tax on import of oil products, for landscaping, etc.) needed for expansion of lands covered with forestry vegetation, etc.	2009–2010
Development and approval of the Regulation on the principles and manner of funding priority forestry activities, on the state's contribution to priority forestry activities (landscaping, research, regeneration and expansion, guarding and protection of forests)	2009–2013
Development and approval of the Regulation on environmental values and payment for their beneficiaries (agricultural landowners, treatment facilities, etc.), as well as establishing an economic infrastructure and a wood products market	2009–2013
Development and approval of the Regulation on implementing and assuring functionality of the principles of participatory management of public forest resources	2009–2013
Development and approval of a Regulation on a wide promotion of forestry pastoral and agricultural-forestry practices, to unify the efforts of the forestry, animal breeding and pastoral sectors, mitigate social conflicts, etc.	2009–2013
Approval and implementation by mayors of local regulations pertaining to forest vegetation and grasslands management, including signing agreements between the livestock sector and mayors of contracts for grazing of animals on communal grasslands, which will specify the obligations of the parties in terms of grassland maintenance	2009–2011

Education, Training, Research and Development

Development and implementation of training programmes for owners (initially for staff involved in management, guarding and protection) of communal and private forests and other types of forest vegetation	2009–2013
Organization of training and re-training programmes of forestry professionals in information technologies	2009–2013
Development of methodologies and technologies on assuring adaptability of forest ecosystems to climate change	2009–2010
Description of the natural forest ecosystems in view of adequate execution of forestry works and assessing vulnerability	2009–2013
Development of a general information system for the national forestry sector	2009–2013
Development of software for forest inventory and forest cadastre development	2009–2013

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 $>1^{\circ}\text{C}$ 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 $>40^{\circ}\text{C}$) have also been observed.

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

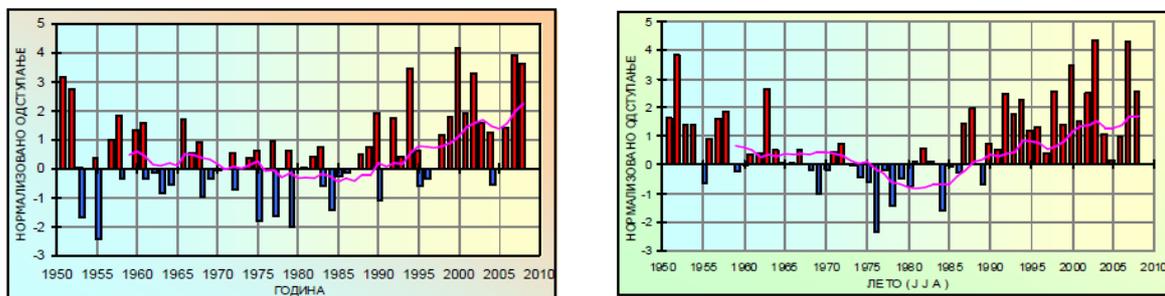
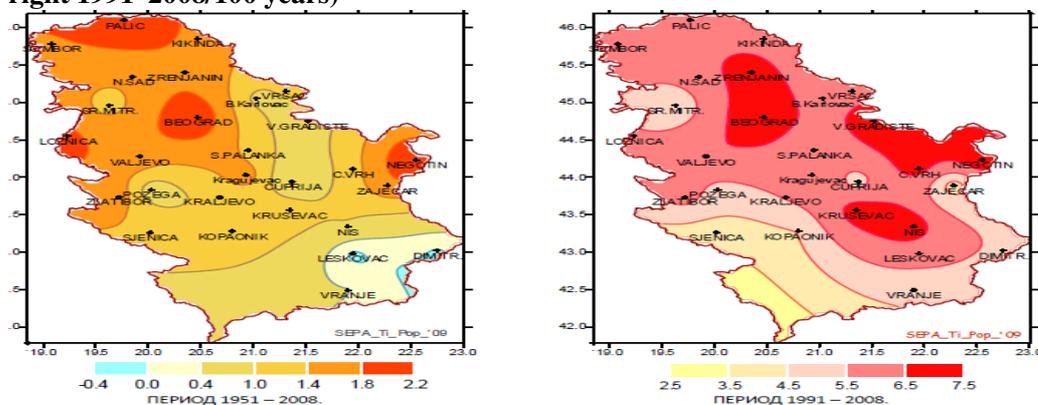


Figure 2. Territorial distribution of annual temperature trend (left: 1951–2008/100 years; right 1991–2008/100 years)



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).

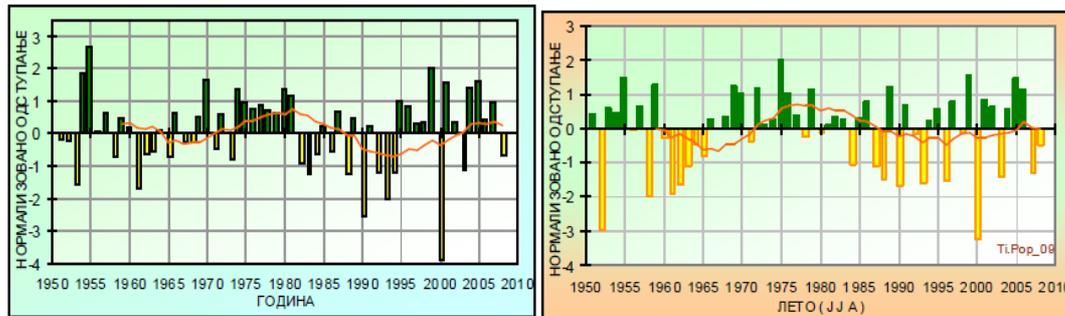
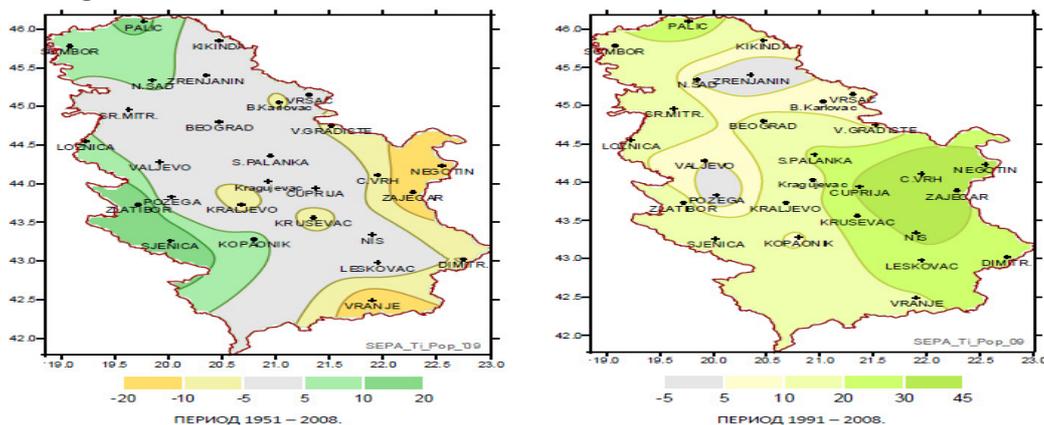


Figure 4. Territorial precipitation trend as percentage of long-term average (left: 1951–2008; right: 1991–2008)



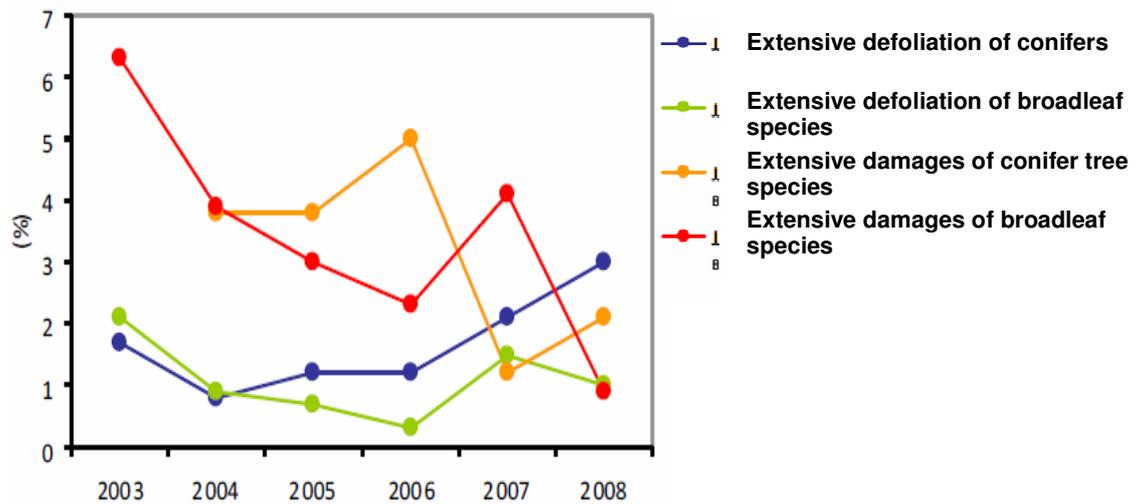
Climate extremes

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.

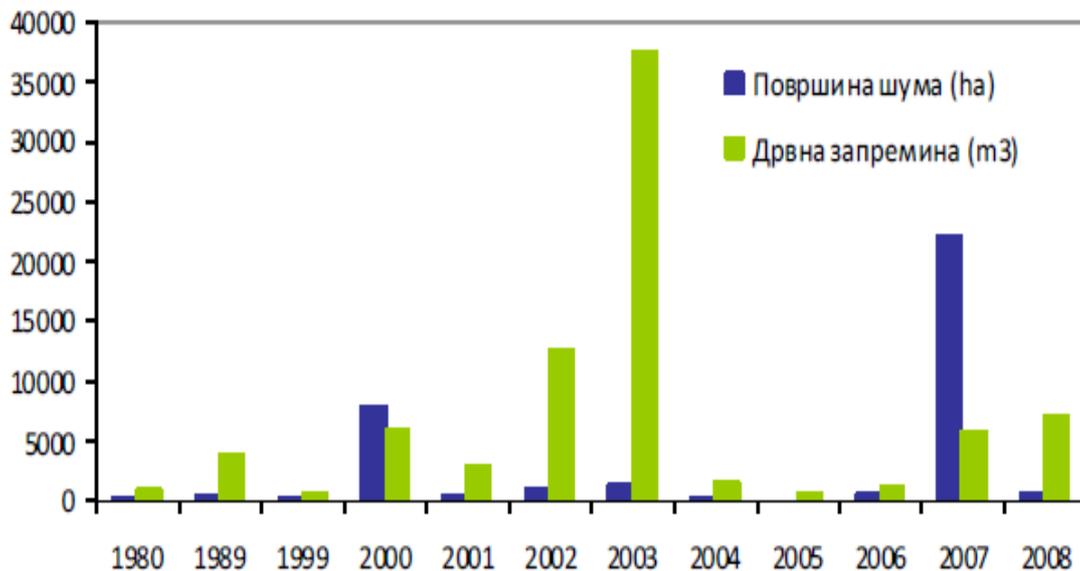
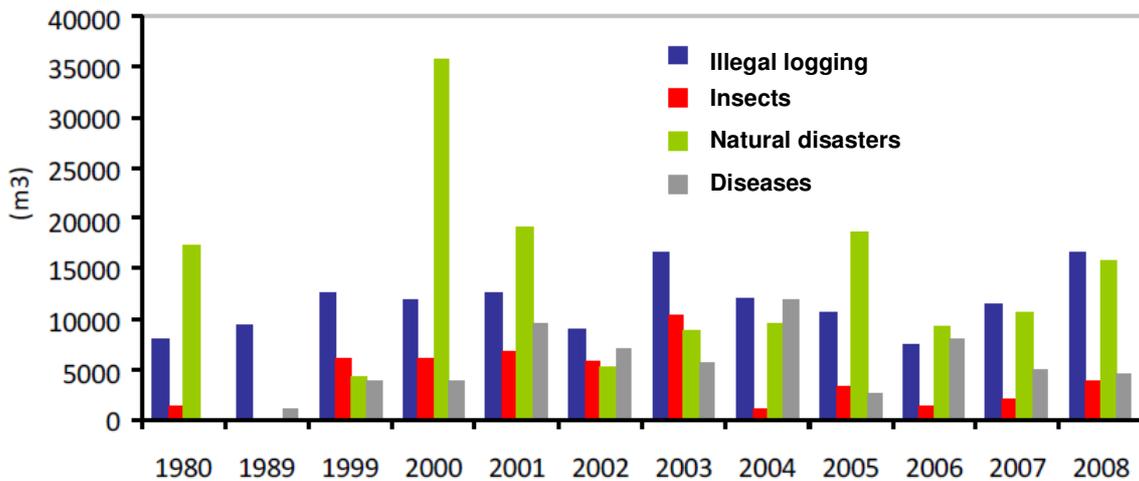


Figure 7. Damage to forests caused by insects, natural disasters and illegal logging



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 proceedings 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 proceedings 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 provide 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 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

Karadžić, 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 (CO₂), 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 CO₂ 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 brunus* (Steph.)) and pine processionary moth (*Thaumtopoea pytiocampa* Schiff.). Other species whose damage area could expand are grasshoppers (*Caliptamus italicus* (L.), *Locusta migratoria* L. and *Doclostaurus maroccanus* (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

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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.

TURKEY

Ünal Asan

Background

Turkey ratified UNFCCC in 2004, and established a National Coordination Board on Climate Change (NCBCC) by Circular No. 25377 of the Prime Ministry in the same year. An inter-ministerial coordination board on climate change had been initially established in 2001, but it was revised by the Circular of the Prime Ministry in 2004 to become NCBCC. The board has overall responsibility for climate change policies. According to working procedures of the board, 8 Working Groups (WG) were initially established to carry out research into the effects of climate change (WG1), emission inventory of GHGs (WG2), mitigation of GHGs from industry, building and the waste sector (WG3), mitigation of GHGs from the energy sector (WG4), from the transport sector (WG5), from the LULUCF sector (WG6), development of policies and strategies (WG7), and education and public awareness (WG8). The number of WGs was increased to 10 by adding adaptation (WG9) and finance (WG10) in 2008. Responsibility for the last three sectors, together with general coordination of the board, were assigned to the Ministry of Environment and Forest (MoEF).

MoEF is the National Focal Point for climate change and is the coordinating governmental body for all issues related to climate change in Turkey. At the same time, MoEF is the focal point for the European Environmental Agency and is going to establish a link to the European Environmental Information and Observation Network for fulfilment of reporting requirements.

Within MoEF, there are departments related to sectoral emissions control and environmental impact assessment. Harmonizing the existing environmental legislation with the EU *acquis* lies within the responsibilities of MoEF. The Ministry is primarily responsible for forestry activities across the country. Thus, WG6 is the most effective body in the MoEF. Missions of the LULUCF WG are:

- Determination of land use status and its integration into a GIS.
- Determination of sinks and emissions in order to estimate net CO₂ flux
- Development of some suggestions for formulating legal regulations and creating intensive mechanisms in order to reduce GHGs by considering economic and social circumstances.
- Initiate some work in order to reduce GHG effects generated by agriculture and livestock activities.

Turkey collaborated with UNDP in 2005 to produce the First National Communication (FNC) with a GHG inventory under a project titled “*Enabling Activities for the Preparation of Turkey’s Initial National Communication to the UNFCCC*”. Annual stock changes of carbon in the forests of Turkey, and other GHG releases in the period 1990–2004 were estimated through a subproject. The IPCC manual “*Good Practice Guidance for Land Use, Land Use Change and Forests*” (GPG-LULUCF) was used in the estimation of carbon stock changes and the inventory of other GHGs. The first communication was reviewed by UNFCCC experts (FCCC/ARR/2006/TUR). All the queries were answered in the revision. The second, third and fourth communications for 2005, 2006 and 2007 were submitted and controlled by the independent UNFCCC experts.

Turkey provided a complete time series only for carbon stock changes, excluding soils and litter, in the categories forest land, remaining forest land and land converted to forest land, and for non-CO₂ emissions from biomass burning under forest land. Because of the absence of adequate data for carbon in organic forest soils, and for the litter amount in varying forest types by climate regions, these two carbon pools could not be taken into account in calculations. Some coefficients used as converting factors are also need refinement and improvement. Area changes among land use forms are not based on GIS due to lack of suitable data sources.

As a member of OECD, Turkey was included among the countries of the Convention's Annexes I and II when UNFCCC was adopted in 1992. Turkey was later removed from Annex II of the Convention (Decision 26/CP.7) at COP 7 in Marrakech, 2001. Thus, Turkey remains an Annex I Party to UNFCCC, but with an anomalous status compared with other Annex I countries. Turkey was not a Party to UNFCCC when the Kyoto Protocol was adopted. Therefore Turkey does not appear in Annex-B of the Protocol, which lists the individual targets for Annex I Parties, and had no quantified emission limitation or reduction commitments within the first commitment period of the Protocol. Although Turkey had no obligation to commit a mitigation target to UNFCCC, since 2007 it has been taking an active part in negotiations on further commitments under the Kyoto Protocol and UNFCCC. All national communications submitted before 2009, and the communications to be presented until 2012, should be considered voluntary communications with no responsibility, due to this late admission. Nevertheless, it is expected to contribute to climate change mitigation, including through the LULUCF sector, post 2012. Thus, Turkey has to develop a sound strategy for mitigation. Sustainable management of forests, forestation, reforestation and forest restoration are important mitigation options in this context.

As an implementing agency, UNDP provides support to the NCBC by developing the capacities of Turkey to participate efficiently in international climate change negotiations and to join the flexible mechanisms of the Kyoto Protocol through better experience of the voluntary carbon markets.

GEF, UNEP and UNDP have provided support to certain developing country projects that have global environmental benefits, not only in the area of climate change but also in biodiversity conservation and in. Since Turkey has signed the conventions on climate change, on biodiversity and on combating desertification, sometimes called the Rio Trio, all of the documents concerning these three conventions should be considered in an integrated system for a responsible policy.

Summary of climate change dimensions

Data sources concerning the forests

There are only two reports concerning national forest inventory results in Turkey. The first shows the 1972 situation, while the second has data for 2004. The changes and plus/minus differences among the forest forms and tree species between 1972 and 2004 are outlined in Table 1. Detailed documentation related to the changes on forest resources is given in the bibliography.

Table 1. The changes in forest resources between 1972 and 2004.

	Area (ha)	Differences in	
		Growing stock (without bark m ³)	Current annual increment (without bark m ³)
Coniferous high forest	2 023 164	269 997 710	6 642 068
Broadleaved high forest	740 151	99 980 697	2 474 961
Total high forest	2 763 316	369 978 407	9 117 029
Coppice	-998 552	-23 782 554	-1 182 668
Total Forest	1 764 764	346 195 853	7 934 361
Degraded forest (Other Wooded Lands) ¹	1 741 672	11 077 894	174342
Degraded Coppice ((Other Wooded Lands) ¹	-2 516 985	-13 967 258	-247045
Total degraded forest	-775 313	-2 889 364	-72703
Grand Total (Forestland + Other Wooded Land)	989 450	343 175 168	7 861 658

¹Degraded forests cover the areas having <10% crown closure, termed Other Wooded Lands in FAO documents. These areas are accepted as forestland under Turkish Forestry Legislation. SOURCE: GDF 2007

From Table 1, it is evident that:

- The total area, growing stock and volume increments of the coppice forests reduced while high forests were increasing. Most decrease occurred in degraded coppices.
- The total growing stocks and annual volume increment of the coniferous and deciduous tree species increased. More than 80% of the increase occurred in coniferous tree species.
- The total increase in area is 989 450 ha; growing stock and volume increments are 343 175 168 m³ and 7 861 658 m³, respectively.
- Reduction in the areas of deciduous tree species, total growing stock and current annual increment accrued because of conversion of coppice into high forest, and leaving of tree cuttings on some older managed forests for nature protection.
- According to the results of these two inventories, forest area increased by 5%, and the growing stock volume by 35%. Annual volume increment (29%) was high during the 32-year period between 1972 and 2004.

Probable reasons for these changes include:

- Rural-urban migration.
- Less traditional goat husbandry and cattle grazing in the forests and meadows adjacent to forests.
- Abandonment of some forest lands on steep slopes, with uneconomic management conditions.
- Changing attitudes in forestry, moving towards multi-functional use of forest resources in the framework of sustainable forestry management (SFM) concepts.
- Conversion of coppices into high forests.
- Afforestation activities on bare lands and degraded forests areas accomplished by the Forestry Service.

National research climate change in Turkey

The findings of the Fourth Assessment Report of the IPCC underlined the need for immediate action to reduce the amount of anthropogenic GHGs emitted to the atmosphere, in order to mitigate its effects. The report also noted that a portfolio of alternatives offering enough flexibility to accommodate different national circumstances and interests will be required to achieve this goal. The importance of the global participation of developing countries is also emphasized in the report, particularly to improve their competence in the international mitigation effort post-2012.

Turkey has significant GHG emissions reduction potential. At the same time, climate change has the highest priority in the environmental agenda of the EU. As a candidate country for full EU membership, Turkey is striving to conform to EU climate change policy. Thus, to formulate a country position in post-Kyoto negotiations is a priority task for Turkey.

Work accomplished related to LULUCF and REDD

Turkey had submitted four national communications by 2009. Second-level communication (Tier 2) methods given in the manual (GPG-LULUCF) were applied during the preparation of the national communications. Since countries are encouraged to use their own figures, some of the coefficients, such as biomass expansion factors (BEF₁, BEF₂) and Oven-dry mass (D), were derived by a national expert group using existing documentation on forest resources, forestry applications, biomass studies, and other relevant topics. Some other necessary coefficients, like root-to-shoot ratios (R) and combustion factors, were taken from the Annex tables in the manual. Gross and net carbon stock changes between 1990 and 2007 are given in Table 2.

Table 2. Gross and net carbon stock changes in the forests of Turkey between 1990 and 2007.

Year	Gross carbon increase Gg (million tonne)/year	Carbon lost Gg (million tonne)/year	Net carbon sequestration Gg (million tonne)/year
1990	17 984	5 871	12 113
1991	18 075	5 675	12 400
1992	18 194	5 687	12 507
1993	18 323	5 737	12 587
1994	18 325	5 332	12 992
1995	18 585	5 722	12 864
1996	18 714	5 784	12 930
1997	18 765	5 348	13 417
1998	18 863	5 202	13 661
1999	18 979	5 126	13 853
2000	19 112	5 300	13 812
2001	19 200	4 937	14 263
2002	19 405	5 284	14 121
2003	19 517	5 161	14 356
2004	19 712	5 429	14 284
2005	19 410	5 429	13 981
2006	20 126	5 500	14 626
2007	20 314	5 773	14 541

Source: National Inventory Report of Turkey (GDF, 2007).

REDD and REDD+ mechanisms for reducing emissions from deforestation and forest degradation are key mitigation options identified for developing countries. As an Annex I party, Turkey would not stand to benefit from the REDD and REDD+ mechanisms. There is a regular increasing trend in both forestland and growing stock. Although there is limited deforestation and biomass loss around large cities due to rural-urban migration, total forestlands have expanded (5% in 35 years), and total biomass has been increasing (35% in 35 years) annually in the country. SFM with 6 criteria and 28 indicators has been applied in forest management planning under the name of “Ecosystem-Based Functional Planning” since 2005.

Expected stock changes in the future

Carbon stock changes in the future are estimated by means of trend analyses. Data given in Table 2 was used to predict gross increases, carbon lost, and net sequestration. Carbon stock changes and CO₂ equivalents of net carbon sequestration between 2008 and 2020 are shown in Figure 1. As can be seen from the graphs, there is an increasing trend in gross and net carbon stocks with a decreasing trend in carbon lost, for the reasons discussed earlier.

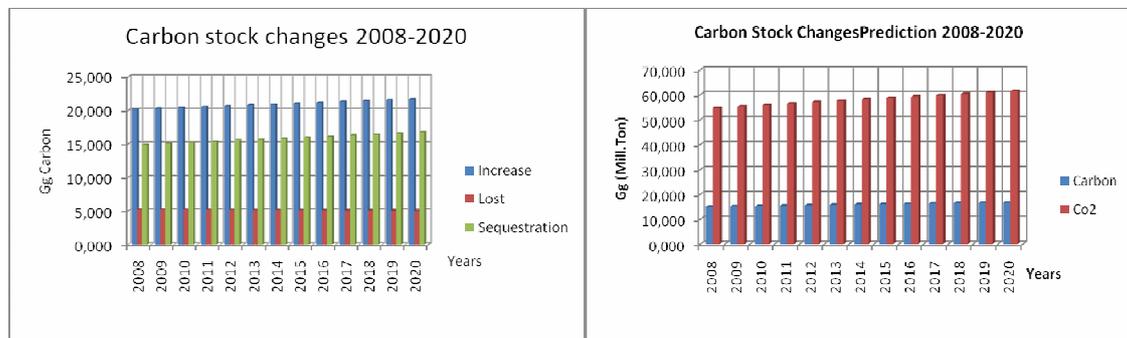


Figure 1. Estimated net carbon stock changes and its CO₂ equivalent to 2020

Rural-urban migration, in particular from villages in the forests, is increasingly annually. The ongoing actions on adaptation of a functional planning approach based on a forest ecosystem mentality, converting coppices into high forests, rehabilitation of forests with poor plant density, and afforestation and reforestation activities on bare lands and degraded forests, the new system to combat forest fires, and ICP Forest Level I and Level II plots installed for observation of forest health and damage are very important and preferable policies applied by the Forestry Service during the last decade. Observation and data collection activities from 721 Level I and 15 Level II plots for 2008 are currently being analysed (www.icp-forests.org/).

From the results of forest inventory, half of the forestlands are non-productive and degraded forest stands (8.43 m³/ha growing stock and 0.23 m³/ha volume increment on average). At the same time, one-third of the productive forests have low density (0.11–0.40 crown closure) and are very old. Turkey prepared an action plan to convert degraded forestlands into productive forests by means of forestation, reforestation and rehabilitation activities.

There is no doubt that this large extent of degraded forests should be seen as having a huge potential for carbon sequestration. Turkey has a great opportunity to promote affirmative effect on climate change by accruing carbon stocks in the forests.

Status of assessment and research on climate change

Reports

There are two main works related to assessment of climate change in Turkey:

- Grand National Assembly Investigation Commission Report on “The Effect of Global Warming and Sustainable Management of Water Sources” (2007).
- MoEF’s Report “Climate Change and the Studies” (2008).

The first report was prepared by a special commission on behalf of the Grand National Assembly of Turkey. Dimensions and impacts of climate change, mitigation and adaptation policies to prevent its negative effects, and sustainability of water sources were elaborated in detail in this document. Subsequently, all studies related to climate change in Turkey were compiled in the second report, prepared by MoEF. Many aspects of the issue were clarified in detail in the report, such as observed and expected changes in the climate; comparison of GHG emissions in Turkey with some other countries; mitigation actions for reduction of GHGs in various sectors, like energy, transportation, industry and so on; forestation and reforestation activities; research and development; training and awareness; and capacity building. In addition, there are the four national GHG inventory reports submitted to UNFCCC (www.ogm.gov.tr/iklim/index.htm).

Studies and works

A Web site (www.ogm.gov.tr/iklim) was constructed. All kinds of studies and the reports on climate change were shared with the relevant parties. The following studies have been realized by the General Directorate of Forest (GDF) and its Climate Change Working Group (www.ogm.gov.tr/iklim/index.htm):

- The National Afforestation Action Plan between the years 2008–2012 was prepared by GDF. 2 300 000 ha of non-productive degraded forest will be converted to productive forestlands by means of rehabilitation and reforestation actions.
- A technical report on energy production from woody biomass was prepared by a special commission.
- The GPG-LULUCF manual was translated into Turkish.
- A booklet on “Strategic Framework for Forests and Climate Change” was translated into Turkish.

- Turkey presented its FRA-2010 Report based on the guidelines set out in FAO Working Paper 143.
- Criteria and Indicators for Sustainable Forest Management Report for 2006.

Finished and continuing projects related to climate change and mitigation actions, supported by FAO and GEF

FAO Projects

- Enhancing the Capacity of Turkey to Adapt to Climate Change.
- Capacity Building for Climate Change Management in Turkey.
- Developing Turkey's National Climate Change Action Plan Project.

GEF Projects related to forestry and climate change

- Enhancing coverage and management effectiveness of the subsystem of forest protected areas in Turkey's national system of protected areas (Kure Mountains).
- Capacity building for monitoring GHG emissions in the LULUCF sector (MoEF and UNDP, in preparation).
- Capacity Building in Sustainable Forest Management Planning and Forest Fire Management in Syria. This is a cooperative project supported by FAO-Turkey Partnership Programme (FTPP).

Proposed areas for cooperation

Possibilities and options for collaboration between FAO and national institutions and specialists on climate change mitigation and adaptation in the forestry sector in Turkey include:

- Turkey is in a weak position in the process of negotiation actions ongoing under UNFCCC because of lack of experience and knowledge. Turkey should be encouraged to participate in negotiation actions by means of training courses on various issues of mitigation actions. Organizing of the necessary courses for supporting capacity building for government representatives in international climate change negotiations could be a collaboration possibility for FAO.
- Organization of a number of awareness raising activities for efficient participation in the VCM for various target groups through workshops, training sessions, promotional materials and sharing of experience.
- The SFM concept is gaining importance in negotiations on reducing emissions from deforestation and forest degradations (REDD/REDD+). It has also been accepted as an important concept in regional and international forest processes and a basis for timber certification in developed countries. Certification of forest enterprises or forest products processing industries is the main issue in Turkish forestry. There is no independent institution in the country authorized to certify either forest enterprises or the forest products processing industry in the country. Such activities are the concern of NGOs or other independent entities in the developed countries. Establishing a certification agency in order to fill this gap seems a useful and fruitful collaboration area for FAO and NGOs such as The Chambers of Forest Engineers, The Assembly of Turkish Foresters, and The Turkish Foundation for Combating Erosion and Desertification (TEMA).
- Definition of the criteria and indicators of SFM on a regional basis in a country is another aspect of certified SFM actions that should be considered during the negotiation of GHG emission reduction among the developed countries, as well as sound and reliable communications obtained through MRV reporting. Turkey has been applying SFM with 6 criteria and 28 indicators in its forest management planning under the name of "Ecosystem-Based Functional Planning" since 2005. The criteria and indicators of SFM were determined by GDF for the whole country, but limited to its own responsibility. Although,

one of the six criteria is to protect and enhance the carbon balance in forestlands for pan-European countries, it is not sufficiently stressed in the Turkish SFM criteria. A PhD study has looked at the issue and 8 criteria with 69 indicators were defined, but definition of the criteria and indicators of the SFM on a regional basis are still on the agenda of Turkey. Revision of existing statements supporting a few regional projects aiming to define these criteria could be another opportunity for cooperation with FAO. Organization of the varying stakeholders or target groups for efficient participation in these projects seems to be a good objective for the collaboration.

- Turkey had submitted four national communication reports by 2008. GPG-LULUCF was used on Tier 2 level in the estimation of carbon stock changes and other GHG inventories. Because of the absence of adequate data for carbon in the organic forest soils, and the litter amount in varying forest types with regard to climate regions, these two carbon pools were not taken into account in calculations. Turkey has to complete the necessary document required for the Tier 3 communication level applying MRV principles if it wants to benefit from CDM funds for NAMA projects. There are many problems restricting upgrading the communication level to Tier 3 that should be investigated in Turkey.

The following studies should be finished to increase the efficiency of future national communications (www.jrc.ec.europa.eu/):

- Revision of the climatic regions map.
- Construction of biomass tables for both productive and non-productive coppice forests.
- Construction of biomass tables for poplar and other species used in plantation agriculture, such as olive, citrus, hazel and tea.
- Research into carbon quantities in organic forest soils and litter according to climatic region.
- Development of a new inventory system using satellite-based remote sensing technologies for identification and monitoring of the various land-use categories.
- Turkey has to develop a definite application strategy either to enhance carbon stocks in the forests or to take mitigation actions for reduction policy.

A research project to complete these documentation lacks was presented to The Scientific and Technological Research Council of Turkey (Turkish: Türkiye Bilimsel ve Teknolojik Araştırma Kurumu, TÜBİTAK) by the MoEF Research and Development Department, but it was not approved due to financial problems. FAO could play an important role in this issue by means of its directive projects aiming at complementary studies.

References and other sources used

- Apak, G. and Ubay, B. 2007. First National Communication on Climate Change. 249 pages report with 8 annexes
- Asan, Ü. 2008. Estimation of Annual Carbon Stock Changes & Green House Gasses Inventory in the Forests of Turkey Between the Years 1990-2004. PP Presentation. Technical workshop on Durusoy, I. 2009: Defining National Level Criteria and Indicators for Sustainable Forest Management in Turkish Forestry. (PhD Thesis, 252 Pages.) in Turkish
- FCCC/ARR/2006/TUR: Report of the individual review of the greenhouse gas inventory of Turkey submitted in 2006. 16 Pages.
- Kruse Isınmanın Etkileri ve Su Kaynaklarının Sürdürülebilir Yönetimi Konusunda Kurulan (10/1,4,5,7,9,10,11,13,14,15,16,17) Esas Numaralı Meclis Araştırması Komisyonu Raporu (534 Pages)
- Lorenz, M., Fischer, R., Becher, G., Mues, V., Granke, O., Braslavskaya, T., Bobrinsky, A., Lukina, N., Clarke, N., Lachmanová, Z. & Schimming, C. 2009. Forest condition in Europe. Technical report of ICP forests, 81 pp.

LULUCF reporting issues under Kyoto Protocol. Ispra, Italy, 13-14 November 2008.
www.jrc.ec.europa.eu/

OGM. 2006: Criteria and Indicators for Sustainable Forest Management Report for 2006. 90 Pages, Original in Turkish.

OGM. 2009: Forest Biomass for Renewable Energy. 133 Pages, Original in Turkish. Bioenergy Working Group's Report.

Revised Addendum Text: FCCC/KP/AWGLCA/2009/ 28 August 2009. 36 Pages.
www.ogm.gov.tr/iklim/index.htm
www2.ogm.gov.tr/iklim/reddbilgi.htm
www.ogm.gov.tr/dokumanlar/akakdo310309.doc
iklim.ogm.gov.tr/
[ftp.fao.org/docrep/fao/meeting/013/ai784e.pdf](ftp://ftp.fao.org/docrep/fao/meeting/013/ai784e.pdf)
www.fao.org/docrep/006/y5097e/y5097e00.htm
[www.fao.org/forestry/climate change/en/](http://www.fao.org/forestry/climate%20change/en/)
[www.fao.org/forestry/climate change/28300/en/](http://www.fao.org/forestry/climate%20change/28300/en/)
www.icp-forests.org/Rep.Tec.htm

TURKMENISTAN

Akmurat Atamuradov

General observations

The independent and neutral State of Turkmenistan is situated in the western part of Central Asia, bordered by Kazakhstan, Uzbekistan, the Islamic Republic of Iran and Afghanistan. The country covers an area of 491 200 km². The capital city is Ashgabat.

Climate

Turkmenistan has an extreme continental climate, except for in the coastal areas of the Caspian Sea and in the mountains. The average annual air temperature ranges from 12° to 17°C in the north, to 15° to 18°C in the southeast. The coldest month is January, with average temperatures ranging from -6°C in the northeast to +4°C in the southeast, and +5°C in the far west. The average temperature during the hottest month, July, is from 27 to 30°C. The absolute maximum temperature reaches 48 to 50°C in the Central and South-East Karakum Desert, and a little lower in the north of Turkmenistan, on the Caspian Sea coast and in the mountain regions. The highest rainfall occurs in the mountains and foothills, averaging up to 398 mm, and the lowest rainfall occurs in the Kara-Bogaz-Gol Bay, averaging 95 mm. Rainfall in the northeast averages 105 mm.

A total of 80% of the territory of Turkmenistan is desert, which has a significant impact on the climate of the country as a whole. The Karakum Desert is one of the largest deserts in the world, and occupies the whole central part of the country. Four fifths of the territory of Turkmenistan is flat. Mountains and hills are mostly in the south and southwest of the country.

Land use

Of the total land area of Turkmenistan, 282 420 km² is desert (ca 80%). Since independence, Turkmenistan has developed a specialized form of agriculture: cotton and wheat cultivation, breeding karakul sheep, and silk production. The main land users are agricultural peasant associations, which account for over 70% of land use in the country. Of the total land area, 17 million hectares are suitable for agricultural cultivation, of which over 10% is currently being used. Irrigation is used for over 70% of agricultural production.

Water resources are extremely unequal in distribution: 95% comes from the Amu Darya river, and the remaining 5% from all other rivers, streams and springs. The southern Murghab, Tedzhen and Sumbar rivers, and the smaller rivers of the foothills of the Kopet Dag, are fully exploited for irrigation. The building of the Karakum Canal has changed the redistribution of water resources across Turkmenistan. It has removed imbalance in the distribution of water between the large areas of cotton growing land in one part of the country and the water resources in the other.

Forestry

Owing to Turkmenistan's specific natural and climatic features, over 4 126 000 ha of land are covered in forest, which is why all forests are classified as primary, by order of the Government, and why final felling is not carried out and not planned for the future. Forest, in the arid climate of Turkmenistan, is of particular ecological importance. In the new economic circumstances, the importance of forestry is increasing continuously, which requires specific activities in that sector to be defined in order to ensure genuine accountability and in order to guarantee access to full information. The removal of timber only takes place in the context of sanitary felling, amounting to no more than 30 000 to 50 000 m³ per year. Natural gas is provided to the population free of charge, which means that over recent years there has been a reduction in unauthorized felling. In 2004, a paper factory began operation, producing around 50 000 t of paper per year, using cotton

plant material and corn chaff as raw materials. Cattle grazing is restricted in areas where it could damage forest growth and development, particularly in young forest areas.

Of all the countries in Central Asia, which have many similarities, Turkmenistan differs in the uniqueness of its forest coverage. The unique natural and climatic conditions are conducive to the growth of a range of plants, particularly trees and shrubs, from the Caucasus and Mediterranean regions, as well as from the western Tien Shan, with the extreme continental climate leading to a range in diversity between the forests of the mountains and foothills, and those of the sandy desert areas, particularly with respect to their ability to store water internally.

Throughout their history, the forests of Turkmenistan have been subjected to various negative impacts, since the early development of human society. Efforts to conserve and protect the forests only began within the last 100 years. Forest conservation in natural areas has been made possible by limiting human use of forest resources and some national traditions, but most importantly, by the miraculous capacity of the plants to grow in such severe conditions.

National climate change situation

The conclusion of the group of experts in a climate change report published in 2007 states that climate change is already happening, and even if counter measures are taken immediately, the consequences cannot immediately be reversed. However, the most promising measures for reducing CO₂ emissions in the atmosphere for the non-energy sector are to increase carbon sequestration while expanding the area of forest plantations and the restoration of perennial shrubs and herbaceous plants on lands that are deteriorating or being withdrawn from arable farming use. Forest carbon sequestration is directly related to temperature, which means that the absorption rate increases at high temperatures. At the same time, the carbon sequestration rate of coniferous and deciduous forests growing in warm and temperate climates is higher than of those growing in northern latitudes.

In recent years, Turkmenistan has gained experience in forest cultivation using introduced species of trees and shrubs. Eldar pine (*Pinus eldarica*) is very hardy in adverse climatic conditions and continues to grow year by year. It should be noted that forest conditions in Turkmenistan are very harsh, and therefore significantly limit the range of species suitable for silvicultural activities.

In Turkmenistan, considerable work is being carried out on the planting of perennial tree plantations, mostly using coniferous seedlings. A number of government decrees have been issued on the subject, including:

- On the development of horticulture and landscape gardening in Turkmenistan, 1992.
- On the creation of parklands in the foothills of the Kopet Dag, 1998.

Each year the need for recreational forest land is increasing. This raises the issue of needing to revise the designation of forests by categories of protection, and the possibility of setting aside parts of protected forests as forest land for recreational use.

The forest park areas around the capital and in the foothills of the Kopet Dag are particularly noteworthy. Work on the establishment of this unique forest began in 1998, pursuant to Presidential Decree No. 3784 of 22 July 1998 on the creation of parklands in the foothills of the Kopet Dag. This measure is a logical continuation of the Presidential Decree on the development of horticulture and landscape gardening in Turkmenistan, which provides for the renewal of good traditions for further development, which have been lagging behind in recent years in this important sector. Almost all sectors of the economy were mobilized to establish the forest parklands in the foothills of the Kopet Dag. All ministries and departments are mobilizing their own forces and resources to purchase planting materials and to organize planting according to the

recommendations made by the Ministry of Nature Protection. Further cultivation activities have also been organized using their own resources. Forest parkland areas currently cover over 30 000 ha. In total, over 30 million saplings and seedlings of around 100 species of evergreen and deciduous trees and shrubs have been used.

Analysis of the growth and development of plantations shows that the range of species corresponds with forest conditions, and that forest reclamation has a positive effect on the environment and the climate. At the same time, in planting forest parklands, innovative agrotechnological practices have been developed. In this regard, there has been large-scale introduction of drip irrigation, which allows irrigation water to be used economically. Methods for organizing forest fire prevention and tackling diseases and pests have also been developed.

As a result of the alleviation of climatic conditions and the establishment of forests, there has already been an increase in the number of wild animals and birds in forest parkland areas. As a result of regular irrigation, drinking and foraging sources for wild animals have increased. This is an additional factor in preserving biodiversity in forest ecosystems.

By ratifying United Nations instruments on conservation, Turkmenistan is actively participating in international cooperation for the implementation of joint projects to overcome the ecological problems that are giving cause for concern the world over, such as the sensible use of natural resources, in particular water resources, and for their protection and restoration, efforts to combat desertification, combating the exhaustion of land resources, and climate change and global warming. In this regard, Turkmenistan is actively cooperating with neighbouring countries and competent international organizations, including UN, EU, GEF and many others. A good example of this cooperation is the project for sustainable management of forest resources in Turkmenistan, which is being implemented with support from the German Agency for Technical Cooperation (GTZ).

The following measures have been taken to address climate change in Turkmenistan:

- Turkmenistan ratified the UNFCCC in 1995 and the Kyoto Protocol in 1998. As part of its obligations under the Convention, Turkmenistan has conducted an inventory of its GHG emissions since 1994.
- The First National Communication (FNC) on climate change was drafted and published in 1999, based on materials from studies conducted between 1997 and 1999. This communication presented information on the country's GHG emissions and Turkmenistan's measures to meet its obligations under the UNFCCC, as well as to adapt to predicted changes in climate and proposed measures for the reduction of GHG emissions.
- The second phase, an integral part of the FNC, continues. This phase includes capacity building in priority areas of the national economy in connection with climate change. Specific objectives of the project include bridging gaps and identifying and evaluating the technological requirements for fulfilling the fundamental objectives of the UNFCCC.

On 15 August 2009, the Ozone Layer Protection Act was adopted. The Act sets out the legal, economic and organizational aspects of protecting the ozone layer, as well as State governance and monitoring of the handling of ozone depleting substances, and aims to protect and restore the ozone layer in order to protect human health and the environment from the negative consequences of ozone layer destruction. The Act clearly defines offences in respect of the protection of the ozone layer and liability for committing such offences. It also provides for State regulation of activities for the protection of the ozone layer.

- The forests and pastures laboratory of the National Institute of Deserts, Flora and Fauna of the Ministry of Nature Protection conducted scientific research in 2009 on the influence of drought on pastures.

- In 2003, the Ministry of Nature Protection drafted and published a brochure on climate change and sustainable development. This publication presents, in an accessible format, information on the earth's atmosphere, weather and climate, natural variations and the anthropology of climate change, the main cause of which is the increase in the concentration of GHGs.
- An article written by specialists from the Ministry of Nature Protection, entitled "Turkmenistan's contribution to overcoming global climate change" was published in the journal "Problems of desert reclamation". The article describes specific steps being taken in Turkmenistan, supported by the global community, to prevent environmental degradation.

In the long term, freshwater resources in Central Asia are expected to decrease by 20 to 30%, which could result in a reduction in crop yields and the yield of pasture lands. In this regard, Turkmenistan is taking measures to ensure sensible use of secondary water resources. In 2009, the Altyn Asyr Lake was constructed in the Karakum Desert to collect all drainage water from across the country.

Improving the water supply in the new territories will enable desert pasture areas to be enlarged for livestock rearing, and to increase the resultant plant reclamation activities. The seeding and planting of sand-tolerant species—white and black saxaul trees, saltwort, ephedra, desert acacia and many other species—will create conditions for year-round pasture for cattle, which will improve the conditions of their winter grazing. All these efforts will enable the further development of livestock rearing in Turkmenistan and will improve the social and living conditions of workers in that sector.

Activities of research institutes and other institutes and organizations

In Turkmenistan, meteorological, hydrological and agro-meteorological monitoring are conducted by the National Committee for Hydrometeorology of the Cabinet of Ministers, which conducts lake and sea analyses and ozone and radiation measuring activities, as well as monitoring pollution. The collection and storage of climate-related information is conducted by the State hydrometeorological data fund. Computerized databases and data banks of climate data are being established and used in operational and scientific work. This data enables evaluations to be made of climatic anomalies, through scientific research. All information is studied by the State Commission for the fulfilment of Turkmenistan's obligations under the United Nations environment conventions and programmes, established with a view to coordinating the activities of ministries and departments dealing with environmental issues, as well as for the development of national policies for reducing negative anthropological effects on the climate, and ensuring that the concentration of GHGs in the atmosphere is reduced to a safe level. Forest adaptation and climate change issues in Central Asia are addressed by the Uzbek Institute for Forest Research (formerly the Central Asian Institute for Forest Research). In Turkmenistan, the National Institute for Deserts, Flora and Fauna of the Ministry of Nature Protection is the main scientific research centre. Pilot activities for the development and introduction of innovative technologies and agro-technology in forest management are being conducted by the Turkmen forest experiment station and the Inspectorate for forest planting and the protection of natural parks of the Ministry of Nature Protection.

Work is also being conducted by the Magtymguly Turkmen State University, the Turkmen Polytechnic Institute and the agricultural research institute of the Ministry of Agriculture, as well as other interested institutions and organizations.

Cooperation with FAO

Given that the rate of climate change and its effects on forest management differ between countries, Turkmenistan considers it would be appropriate to develop the following activities in collaboration with FAO:

- Establish a unified definition of climate change and its impact on forest management at the regional and national levels.
- Develop a national forestry programme.
- Conduct forest inventories.
- Organize international and regional exchanges of experience and new practices and technologies in forest management and other organizational issues.

UKRAINE

Igor Fedorovich Buksha

Study of climate change impact on forest ecosystems, and the development of adaptation strategies in forestry

Ukraine has created and continues to develop a national legislative and regulatory basis relevant to the issue of climate change (Appendix 1). As Ukraine spans five different natural zones and the country is characterized by a variety of ecosystems, the impact of climate change on forests may manifest itself in different ways in different natural zones and at the sub-regional level. This is why contradictory opinions abound on the effects of climate change impact on forests. As an example, Professor Y. Didukh notes that a temperature increase by only 1°C in the conditions of Ukraine results in a 160 km shift in the latitudinal borders of the natural zones. The temperature increase caused by warming will result in increased moisture evaporation from the soil surface. This may result in desertification on the sand dunes of the forest zone (Polesye). In the forest-steppe and steppe zones, climate change will intensify the decomposition of humus and this will result in less humus content in soils and in decreased soil fertility. The level of water surfaces in the south of Ukraine may rise, so will the amount of precipitation, and this will aggravate flooding processes. This, in turn, will result in bogging and salinization of areas, with a negative impact on not only the forests and agricultural production, but also on the quality of life of the population.

The main results of the empirical observations and the climate change forecasts in Ukraine are presented in Appendix 2. One of the first results of a complex assessment of climate change effects on the forestry of Ukraine were obtained within the framework of the international US Aid Programme to developing countries with economies in transition, designated for climate change studies – US Country Studies Program.

The selection and analysis of various climate change scenarios, developed with the use of simulation studies, plays an important role in the research process. The climate change forecast for the conditions of Ukraine was made using four models: CCCM (Canadian Climate Centre Model; sensitivity to doubled atmospheric CO₂ concentration = 3.5°C), GFDL (Geophysics Fluid Dynamics Laboratory model; sensitivity to doubled atmospheric CO₂ concentration = 4.0°C), GISS (Goddard Institute for Space Studies model; sensitivity to doubled atmospheric CO₂ concentration = 4.2°C), and UKMO (United Kingdom Meteorological Office model; sensitivity to doubled atmospheric CO₂ concentration = 3.5°C).

According to the simulation results obtained, a temperature increase is forecast for all seasons of the year on the premise of doubled CO₂ concentration in the atmosphere. Thus, according to the scenarios, developed on the basis of CCCM and GISS simulations, the air temperature will increase most significantly in the winter, and according to GFDL and UKMO it will increase in the spring. According to the last two scenarios, the warming in Ukraine will increase from south to north and will be the greatest in the north, in the region of Ukrainian Polesye during the winter and spring seasons. Under all the scenarios, the amount of precipitation will increase, and during certain seasons this increase could exceed the current level by 20%.

The reaction of forests and forestry to climate change was examined through the assessment of changes at the level of forested regions of Ukraine, areas of main forest-forming species, and forest ecosystems on the territory of Ukraine, together with social, ecological and economic changes in the forestry sector. The forest climate indicators were modelled using D.V. Vorobjov's method. According to this method, the forest climate type is a function of heat and moisture

availability on the territory where the forest is growing. Heat availability (T) and moisture availability (W) are determined according to the following formulas:

- $T = \sum T_i$, where T_i is the sum of average monthly air temperatures for the months with above-zero temperatures; and
- $W = P/T - 0.0286 \cdot T$, where P is the amount of precipitation for the months with above-zero temperatures.

The generalization of the simulation results showed that due to the temperature mode change, humidity modes and climate continentality changes, the borders of the forest-growing regions and areas will change. Climate change will expand these areas and will contribute to the extension of species with large amplitude, while poorly adapted species with narrow ecological amplitude will diminish and possibly become extinct. Together with the changes in the areas of Ukraine's main forest-forming species, the changes in the forest-growing regions will determine the regional character of the changes in forest ecosystem structures and their biological productivity. At the forest phytocenose level, changes will be seen in dominant species replacement trends, in the storied structures of the timber stands, in growth dynamics and in the stability of plantations.

According to the climate change forecast under the CCCM simulation, considerable warming will take place. The greatest changes in average monthly temperatures are forecast for the southern part of the forest-steppe and steppe zones. The greatest decrease in precipitation is expected in the steppe zone, while the average yearly precipitation amount will increase in the north and north-west of the country. The climatic conditions determining the forest vegetation zones will move towards dryer and warmer types. Possibly, a zone of warm dry woods, widespread in central United States of America, will appear here and this will be quite unusual for Ukraine. The forest growth conditions in the steppe zone will be similar to the steppe conditions of Spain. The Crimean peninsula will see conditions appear that will be suitable for the growth of subtropical thorn woodland forests. The moderate warm dry forest zone will occupy the territory of the current forest-steppe zone and partially the territory of the forest zone. In the northern part of the country (forest zone of Polesye), a region with a considerably warmer climate will develop, which will result in unfavourable conditions for the main forest-forming species. Simulation of the dynamics of the areas of the main forest-forming species shows that as a result of climate change the forest acreage may decrease by 47%.

The GFDL climate change forecast model indicated that the climate will become considerably warmer throughout the Ukraine, and the greatest change will take place in the southern part of the forest-steppe and the steppe zones. Most of Ukraine will see a strong xerophytization of forest localities, especially in the south of the country, where precipitation will decrease by 180 mm. At the same time, precipitation in the northwest will increase by 20 mm. The temperature gradient between the warmest and the coldest month will increase considerably: 34°C in the west and >41°C in the northeast, i.e. the climate will become more continental. This will lead to the formation of a steppe and desert ecology on a considerable part of Ukraine; areas suitable for forest growth will remain only in the western part of Polesye. In the steppe and the forest-steppe zones, the climate will change from cold to moderately warm. When the borders of the non-forest territories shift towards the northwest, the growth conditions for the existing tree species will deteriorate and unfavourable climate conditions will be established for all major forest-forming species. Similar climatic conditions for the preserved forest lands may be found in the Almaty region, in Western Jungaria, in Altai and Winnipeg (Canada). The climate of the eastern Pyandj valley in Eastern Turkmenia corresponds to the climate of non-forested territories. According to the bioclimatic potential, the forecast of the GFDL simulation is the most favourable for forests, due to the increased continentality and strong climate aridization the average increase throughout Ukraine will decrease by 2 m³/ha.

The climate change forecast according to the GISS model is also most favourable for forests. A moderately cold and humid forest climate spreads over the entire territory of Ukraine, except for the northern part of the Crimean peninsula and the southern part of the country, where a moderately warm dry climate will prevail. The climate continentality will decrease and this will favourably affect growth and productivity of forest vegetation. As to the bioclimatic potential change, this forecast is the most favourable one for forest growth and development, with forest crop growth across Ukraine increasing by 2.6 m³/ha. However, it is relevant to note that the currently dominant species will continue to grow in the changing conditions, but during the adaptation period their condition may deteriorate.

The climate change forecast according to the UKMO simulation showed that in the forest and the forest-steppe zones of Ukraine the climate will become slightly more humid and the temperature mode will hardly change. In the steppe zone, especially in the Crimea, the climate will become significantly warmer and its humidity will change little. An unrealistic picture is formed in relation to the continentality of the climate: in the southern part of the steppe, the average monthly temperature gradient between the warmest and coldest months changes by ca 3°C per degree of latitude. In general, the distribution of forest and non-forest lands will not significantly change, although the variability of the climatic conditions will increase. The forest zone will shift towards the southeast; this will result in shrinking of the border between the steppe forest developments in favour of forest lands. Among new climatic conditions for Ukraine, one can note the appearance of a moderately cold wet forest zone. A moderately warm dry forest zone will be formed in the south of the country. The areas of main forest-forming species will decrease drastically. In general they will shift to the northwest, conditioned by the increase of climate continentality. As to change in bioclimatic potential, this forecast takes an intermediate position among the others. In the north of the country (in the forest zone) growth, on average, will increase by 0.07 m³/ha, in the forest-steppe by 0.13 m³/ha, in the steppe by 0.93 m³/ha, and on average throughout Ukraine by 0.38 m³/ha.

A multi-criteria forest sector assessment matrix has been developed in order to assess the effects of climate change on forestry, incorporating the principles, criteria and indicators that characterize ecological, social and economic aspects of forestry. A semantic model of functional response of the forest sector to the climate change was also developed, which enabled statistical data logging that characterizes the forest sector and the forestal climatic indicator dynamics change simulation, represented by a geographical information system (GIS) as well as the creation of maps of forest-typological indicators.

The generalized results of the climate change impact assessment on the forest sector show that when the GISS and UKMO scenarios are implemented, the revenues of the forest sector of Ukraine will increase by 28.2% and 10.3%, respectively, while under GFGL and CCCM scenarios revenues will decrease by 43.1% and 39.8%, respectively. Such different results from the four (CCCM, GFDL, GISS and UKMO) simulations indicate that these simulations have not been sufficiently adapted for Ukraine. In order to improve the forecasts it is necessary to verify these simulations through consideration of the climate of Ukraine. Such work should be conducted in parallel with the development of national models and climate change scenarios. The experts of the Ukrainian Research Institute for Hydrometeorology have selected for Ukraine the most appropriate 10 out of 23 global general atmosphere circulation simulations, which were used in the Coupled Model Intercomparison Project, Phase 3 (CMIP3 model). However, even these selected models generate differently directed forecasts for precipitation in the 21st century, and are significantly different. The least significant changes in the precipitation mode are forecast by the use of the B1 scenario. Except for the middle of the century, when precipitation may decrease by 0.3%, for all other decades an insignificant precipitation increase is forecast, up to 2.3%, with a final value of 1.8±5.1%. As far as the temperature is concerned, all the simulations forecast a tendency to increase in the 21st century, but the degree of such increase is very different for

different simulations. For the next decade, the simulations forecast both temperature increases up to a maximum of 0.7°C (B1; CGCM3.1-T47), and a decrease of 0.8°C (A1B; UKMO-HadGEM1). By the end of the 21st century, all the simulations forecast average temperature increases for the entire territory of Ukraine relative to 2001–2010, ranging from 0.7° up to 3.0°C (with an average value of 2.0±0.8°C) for scenario B1; ranging from 2.4° up to 4.2°C (with an average value of 3.1±0.7°C) for A1B; and ranging from 2.6° up to 4.6°C (with an average value of 3.8±0.8°C) for A2.

The use of several simulations combined (a set of simulations) is also one of the simulation improvement methods. The research by Professor A.Z. Shvidenko on assessment of climate impact using a number of scenarios of an international group of climate change experts (IPCC scenarios A1F1, A2, B2, B1) shows that during the period to 2030, growth conditions will deteriorate for the eastern European forests. The main effects of this impact will be:

- The growing areas of several species will change due to changes in natural zone borders, and in certain cases certain productive species will disappear completely.
- The modes, the types, the intensity and the impact frequency of various perturbation factors (insects, diseases, fires, etc.) will change.
- Changes will take place in the balance of nutritional elements.
- Certain (mostly negative) changes in stability and viability of forest ecosystems will take place, mostly in the productivity of forest tree and non-tree plants.
- The effectiveness of forest ecosystem ecological functioning will also change, in particular influences on biochemical cycles, biological diversity, etc.
- There will be changes in forest species reproduction cycles, succession dynamics, and forest ecological and social functions.

These effects will have an impact on the forests of Ukraine to various degrees. In particular, effects will depend on the natural zone and on forest growth conditions. So far, Ukraine has little actual data on climate change impact on forest plantations (in terms of changing reserves, sustainability, dieback and restoration of forests) as no special climate change studies have been conducted in forests.

As the anticipated climate changes in their entirety will negatively affect both the forest and the forests' ecological functions, forestry should use measures to adapt and to attenuate the impact of climate change. At present, adaptation measures for the economy sectors (including the forest sector) are under development. The Ministry for the Environment of Ukraine (Minprirody of Ukraine) in 2009 initiated a scientific study “The research of the economy sectors’ vulnerability to the climate change and the definition of adaptation measures”. In addition, the Technical Aid to the Commonwealth of Independent States (TACIS) – Support to Kyoto Protocol Implementation project started in late 2008, with the aim of developing climate change mitigation strategies and the corresponding adaptation measures. According to the national action plan for the implementation of the Kyoto Protocol provisions within the UNFCCC, in 2010 it is planned to develop a national action plan to adapt to climate change, and in 2011 to develop corresponding regional action plans, which take into consideration country regional specifics.

Taking into consideration that the forests of Ukraine perform primarily ecological and social functions, adaptation measures should be based on sustainable development principles and cover not only the forest sector, but also the related economic sectors, particularly the energy sector, industry, agriculture and tourism. The adaptation strategy should aim to minimize the negative consequences of climate change, and to support ecological and productive functions of the forests through supporting their role in the biochemical cycles, biodiversity, agricultural landscape protection, soil and water protection, production of wood and non-wood forest products, recreational and other social services.

Various aspects of climate change impact on forest ecosystems have been studied by local scientists, including on acerose leaf and leaf-eating insects. V.L. Meshkova has developed a phenology theory, according to which the differences in the population dynamics of acerose leaf and leaf-eating insects are explained by differences in speed and conditions of seasonal development of phytophages and the feed species, as well as on the entomophages and phytophages, and that in turn is determined by the ratio of period and speed of air heating and soil thawing in the spring. Here, forest insects serve as a good indicator of climate change and the research of their development dynamics becomes of valuable theoretical and practical value. For the development of poikilothermic organisms, it is not the temperature that is the critical value, but its rate of increase in spring. The measures of the temperature increase speed are the dates of the established transition over 0, 5, 10 and 15°C. In comparison with the period 1961–1990, the dates of stable air temperature transition above 0°C became earlier by 20 days in the steppe, by 15 in the forest-steppe and by 19 in Polesye. The stable air temperature transition dates over 5°C became earlier in these zones by 6, 2 and 3 days, and the transition over 10°C by 3, 7 and 5 days, respectively. Reflecting this, earlier appearance of larvae feeding in the early spring was noted. Thus, the birth of the armyworm of the winter geometer moth and the larvae of red conifer sawfly in the Kharkov region in the 1970s to 1980s was noted not earlier than the third week of April, but during the outbreak in 2001–2003 it was 10–13 April. At the same time, the dates of stable autumn transition of air temperature over 10°C were noted earlier: by one day in the steppe zone, by two days in the forest-steppe zone, but unchanged in Polesye. The dates of stable air temperature transition over 5°C have greatly changed in the steppe, where this phenomenon takes place six days earlier, while in the forest-steppe and in Polesye it is two days earlier.

For climate condition comparison of various regions or with the same region during different years, a climatogram creation method is used that takes into consideration precipitation distribution during the year and its connection with seasonal temperature changes. The climatograms according to Valter-Bremer-Gossen (or Valter's diagrams) allow one to describe the ecological conditions of a certain point or a region, comparing the measurements of average multiple year indicators for different time intervals. They were used to compare different climate change scenarios and the impact of such changes of acerose leaf and leaf-eating insects. The main factors influencing the development of acerose leaf and leaf-eating insects during climate change are:

- The change in survivability of the acerose leaf and leaf-eating insects (may take place as the result of the direct impact of changed weather conditions, increased or decreased optimal temperature period duration, frequency of late spring or early autumn frost, changes in the viability of the forage plants and of the entomophages, or competition with other species for food and habitat).
- Larval feeding conditions change (under the influence of climate change, species viability changes, as do their development speed and their reproductive potential).
- Changes in an area's borders (as the result of changes in hibernation conditions, hot periods, increased survivability of insects as a result of developments during earlier stages or due to decreased action of regulatory abiotic or biotic factors, lack of feeder crops within the limits of the previous area, and development de-synchronization with food sources).
- A seasonal development change in insects (due to vegetation period change).
- The dendroflora stability levels change because of damage caused by the insects (insect injuriousness level change).

The results of the climate change impact on the acerose leaf and leaf-eating insects allow one to conclude that, due to the earlier coming of spring, the acerose leaf and leaf-eating insect incubation shifted to an earlier date. A tendency toward greater tree vulnerability caused by insect infestations from spring to late summer has been observed. Insect miner species have spread significantly over the last few years, and are the insects that produce several generations during a year and are natural successors to open leaf-eating insects, playing an important role in weakening

trees. Increased aridity also weakens trees and aggravates insect damage; decreased continentality contributes to decreased vulnerability of the trees to winter frosts and to summer heat.

The study on climate change effects on Ukraine's forest resources was conducted within the framework of the EU Inco Copernicus programme (SCEFORMA project). The European forest institute, EFISCEN, conducted a forest resources dynamics scenario analysis for Ukraine's forests under climate change. The EFISCEN Model provides the opportunity to study the development of forest resources by classifying plantations by age, reserves and increment; it also allows taking into consideration parameters affecting forests, such as forest management activities, and environment changes in terms of plantation increment changes. The increment change calculation is performed on the basis of the national forest monitoring data, obtained through the ICP Forests Level I station network and the European intensive forest monitoring stations network (EU-EVROFLUX). Thus, the climate change scenarios were taken into consideration that had been obtained on the basis of six different simulations tested at 13 experimental sites in Europe (within the framework of the project LTEEF-II) (www.efi.int/portal/virtual_library/databases/efiscen/projects/lteef-ii). These scenarios were used to forecast changes for Ukraine's forests, similar to those described earlier for GISS and UKMO models.

The base information was used to characterize this country's forests as of 1 January 1996, the condition of the forests and the probable forest harvesting levels, which were simulated for stable climatic conditions and for climate change to 2050. The simulation results showed that if forest harvesting levels are maintained within the framework of the existing forest management system, then by 2050, due to change in the age structure of the forests, the yearly forest harvesting volumes might amount to 11 million m³/yr. If the forest harvesting modes are adapted to climate change and are directed at multi-functional forest use, than by 2050 the yearly stable forest harvesting volumes could reach 22 million m³/yr, due to more effective use of the forest increment.

The results of the EFISCEN model for simulation and for assessment of various forest management strategies (modes) impact on the state of forest resources and on the accumulation of CO₂ in the forests of the State Forest Management Committee (Goskomles) of Ukraine are presented in Table 1.

Table 1. Forest resources dynamics forecast under current and multi-functional forest management.

Indicators	Forest management mode	2010	2015	2020	2025	2050
Annual increment, m ³ /ha	Existing	4.9	4.7	4.6	4.4	3.7
	Multi-functional	5.0	4.8	4.7	4.5	4.2
Average reserves, m ³ /ha	Existing	267	280	293	305	353
	Multi-functional	265	277	287	295	308
Carbon reserves, t/ha	Existing	95	99	104	108	125
	Multi-functional	94	98	102	104	109
Total reserves, million m ³	Existing	1455	1526	1597	1662	1924
	Multi-functional	1444	1510	1564	1608	1679
Carbon reserves, million tonne	Existing	515	540	565	588	680
	Multi-functional	511	534	553	569	594

The assessment of the consequences of various climate change scenario implementation for forestry was developed in a study within the framework of the International US Aid for climate change research in the developing countries and in the countries with economies in transition (US Country Studies Program). The scenario analysis results were used in the creation of the first

national report. The comparison of various scenarios showed that the most favourable changes for forestry are expected under the GFDL model scenario implementation, and the most favourable scenario for the implementation would be GISS and UKMO models. If the CCCM model scenario is realized, then the most vulnerable functions of the forests will be: recreation, preservation of biodiversity, and maintenance of social functions, which will decrease by 62%, 60% and 56%, respectively, in comparison with the present state. Under this scenario, the least vulnerable activity will be transfer of agricultural lands to be used as forest lands on the territories that are highly contaminated by radionuclides, as well industrial supply of biomass to the wood and paper industry, and the absorption of CO₂ that will decrease rather insignificantly in comparison with the current state of affairs (by 11% and 15% respectively). The following measures are recommended to be used as adaptation strategies options for the forest sector during the climate change:

Forestry-based: The improvement of forest protection methods against wildfires; the application of more advanced measures aimed at forest protection against pests; the introduction of resistant tree species, supporting the highest productivity in the forecast climatic conditions.

Scientific and technical: The development of forest condition diagnostic and forecasting methods; modernization of the information support system to be used for making forest management decisions; the development of the scientific and methodological knowledge base for forest protection against pests and diseases; increased scientific research work dealing with the selection and introduction of new forest species, resistant to the forecast climate changes.

Legal and administrative: Development of regulatory mechanisms that establish the principles of the forest management system, and which take into account the effects of climate change; increase in forest user responsibility for forest preservation; creation of a stimulus system aimed at supporting forest management activity directed at supporting social and ecologically important functions of the forests.

Financial: Establishment of insurance and reserve funds to be used for compensation of forest management activity expenses under the conditions of climate change.

It is crucially important that adaptation strategies be based on principles of sustainable forest management. For the implementation of sustainable forest management principles in practice, it is necessary to conduct personnel training and support sustainable forest management systems. For this purpose, forest certification can be used as a practical tool.

According to the results of research conducted in different countries, forest biomass and soils contain about 50% of the total carbon of the land ecosystems; thus forests at present absorb slightly more than a quarter of the total anthropogenic emissions, and this is considered one of the most important ecosystem services in the context of changing climate. The correlation between the anthropogenic emissions and the absorption of GHGs by the forests in Ukraine differs considerably from the average statistical global indicators. The forests of Ukraine during 1990–2008 absorbed on average less than 10% of the total amount of anthropogenic emissions, and this is related to the considerable emissions of GHGs in the country and to low forestation levels. Only 15.7% of the territory of Ukraine is covered with forests (at least three times less than the average forestation level in Europe).

As absorption of GHGs by forests is one of the most important methods to decrease atmospheric GHG concentrations and to reach the goals set by UNFCCC, Ukraine has to broaden its research in this field. The system approach principles were used for the development of theoretical foundations and for the regulatory-informational support system, used for the assessment of the forest phytomass above-ground components, as well as mathematical simulations and algorithms

for GHG inventory and for the carbon balance forecast. The scientific, methodological and practical issues related to GHG inventory in forest management and in land use are discussed in a number of works.

Forest cultivation and forest restoration activities are extremely promising for Ukraine in its efforts to implement the resolutions of UNFCCC and its Kyoto Protocol. Historically, it turned out that Ukraine has a significant potential for the execution of joint projects in national forestry. Ukraine, being one of the less-wooded countries in Europe, has the priority task to increase the forest cover of its territory. The specific proportion of forest land in different natural zones of the country varies from 3.9% to 51%, but in none of these natural zones does it reach an optimal level, i.e. the level when the forest influences in the most effective way the climate, soil, and water quality, and delivering to society important resources, such as wood and non-wood products. According to the UkrNIILHA calculations, the optimal forest coverage on average for Ukraine equals 20%. In order to reach such a level of forest coverage, it will be necessary to create about 2 500 000 ha of new forests. According to the data of the Ukrainian Academy of Sciences, about 10 million hectare of land have to be transferred from agricultural lands to be used for forest cultivation and for the organization of groves according to ecological and economic considerations.

The state target programme “Ukraine’s forests 2010–2015” makes provision for the cultivation of new forests covering about 430 000 ha. According to the preliminary results, these new forests by 2015 will contain about 1.5 million tonne of carbon.

Within the framework of “The Initiative for Climate Change Issues” activity, there were training and educational programmes developed for forest management specialists as well as methodological materials for project preparation, aimed at increasing GHG absorption during forest management activities. Several seminars were conducted in various regions of the country, where local specialists together with national and international experts identified potential forest cultivation projects in the formats approved for joint Kyoto Protocol projects. The first practical work on forest cultivation and on forest restoration with the purpose of absorbing GHGs were conducted within the framework of preparation and development of the BioCarbon project “The Creation of Protective Forest Plantations on Lands Contaminated by Radionuclides in the Conditions of Ukraine’s Polesye”. In Ukraine’s forest zone (Polesye) on the land contaminated by the radionuclide of Kiev and Zhitomirsky regions there were several carbon-sequestration plantations created on an about 4 400 ha.

The results of this special research testify that the creation of new forests in Ukraine, especially in the forest-steppe zone, is an effective and low-cost method to absorb CO₂. Relatively low expenses for the creation of the new forests in Ukraine and favourable natural conditions for their growth and development create attractive perspectives for the implementation of CO₂ sequestration projects in forestry. Ukraine has considerable potential for the execution of forest management measures, aimed at attenuating climate change and this potential can be realized at a relatively low cost.

Current and planned research activity on climate change impact on forests and forestry

The Ministry for the Protection of Environment (www.menr.gov.ua) is the national coordinator for activity dealing with climate change in Ukraine (including research). Using state budget funds and other financing sources (including foreign), the Ministry of Natural Resources (Minprirody) of Ukraine organizes the execution of scientific research on the basis of an open tender. In 2009, within the framework of a public contract, a certain number of researches on climate impact issues were to be performed, including a “Study of Vulnerability of the Sectors of Economy to

Climate Change and the Definition of Protective Measures”, "Analysis of the potential decrease in GHG emission for the period beyond 2012”, and “Development of a National Strategy Project for Ukraine on the Issues of Climate Change for the post-Kyoto Period”. Activities also included work related to the creation of a GHG inventory for the next national communication of Ukraine to the Secretariat of UNFCCC.

At present Ukraine does not have a separate research programme to study the scale and effects of climate on forest ecosystems and on forestry in the country. A number of issues, related to climate change problems in forestry are being studied in the main forest institution of Ukraine, the Ukrainian Scientific-research Institute for Forest Management and Agricultural Melioration, named after G.N. Vysotsky (UkrNIILHA, www.uriffm.org.ua). UkrNIILHA reports to the State Committee on Forestry of Ukraine (Goskomleshoz) and to the National Academy of Sciences of Ukraine. This institute performs fundamental and applied studies at local, regional, national and international levels. The scientific research plan for the next five years stipulates study of various issues dealing with climate change influence on the national forests.

In order to study the climate change impacts on forest ecosystems, UkrNIILHA conducts studies on the improvement of dynamic simulation of forest growing conditions for climate change assessment, which is based on the forest climate typology classification of Professor D.V. Vorobjov. Applied means for the analysis of forest growing condition changes during climate change are also being developed, which are based on GIS technologies. In the future, climate change issues will be studied within the framework of various aspects of forest management studies; in particular, these issues will be included in the prospective plans for scientific and research works, performed by UkrNIILHA and covering the issues of forest monitoring, forest protection, forest cultivation and forest restoration.

However, there are certain problems with the source climate data and with the climate change indicators scenarios (temperature and precipitation change forecasts for the country), which should be received from the climatologists to be used in forest management studies. The Ukrainian Scientific-research Hydrometeorological Institute (www.uhmi.org.ua) performs research and development of the national climate change forecasts. It was expected that 2010 would see new and improved national forecasts, with climate change scenarios developed for the entire country. Such forecasts and scenarios are then supposed to be used for research in different sectors of the economy, and in particular in forestry.

One of the barriers delaying research on climate change impact on forests is an outdated information system for the forest management industry of Ukraine. The database is not sufficiently developed and precludes GIS use in forestry management. The forestry management databases with forest survey descriptions and the forest maps are interlinked, they are not topological, and they have no geographical connection, with the information stored in formats that are not compatible with modern GIS technology. The forestry management information on the nation's forests have different levels of completeness, the best information exists for forests under the management of Goskomles (State Committee for Forests) of Ukraine (about 68% of the country's forests). For all other forests, information is poor, making it more complicated to perform analyses at a national level. The most complete official forest statistics for all of Ukraine's forests reflects their state as of 1 January 1996, and these data have formed the basis for research on climate change impact on the forests of Ukraine; hence there is an urgent need to update all the databases in order to properly adjust all the relevant preliminary assessments.

Because of the need to assess the scale of climate change impact on the forests, UkrNIILHA has developed scientific and methodological approaches to modernize the forestry management information support systems. Such approaches include the development of inventory and forest monitoring methods, implementation of new information and geo-information technologies,

including mobile geo-information systems, modern instruments for measurement, software-hardware systems, and means of remote Earth probing. In order to improve the forestry management information support systems in Ukraine it is crucial to use a modern knowledge base and current information gathering and management technologies. International cooperation plays an important role in this regard. In view of the requirement to harmonize information gathering and processing systems, which provide the information about forests, Ukraine is developing a forest monitoring system and performing preparatory work to conduct a national forest inventory based on selective statistical methods. At this stage, one very important element for the development of forest inventory and monitoring systems for Ukraine is the use of foreign and international expertise in developing such systems. In this regards, FAO support is of utmost importance for Ukraine, coupled with support within the framework of international cooperation from other organizations.

In 2007, Ukraine, with UNDP, developed a project idea and submitted an application for execution through GEF, on "The Improvement of Adaptation Opportunities of Ukraine's Forest Sector to Climate Change". Project premises included:

- Cooperation in the execution of a complex forest ecosystems and forestry management vulnerability assessment in Ukraine on the basis of new knowledge and modern simulations.
- Assistance in the development of a national forestry management adaptation strategy of Ukraine under climate change.
- Assistance in the improvement and modernization of the forest inventory and monitoring system of Ukraine.

Unfortunately, application was not approved for funding. Irregular and insufficient financing of scientific research is one of the main obstacles to implementing a system-based study of climate change in forestry.

Priority directions for future research

The studies so far conducted on problems associated with climate change impact on the forests of Ukraine have predominantly been within the framework of international programmes and projects (Appendix 3). Thus, as a rule, the studies were performed in the format of pilot research with the use of different methods and simulations, which were not always verified and adapted to the conditions of Ukraine. The forest statistics and forest organization data used for these studies were outdated, and so the validity of the results are dubious now.

Nevertheless, the studies conducted allowed the development of a number of methods, approaches and simulations that enable significant improvement in the quality of climate impact assessment on the forests, and created good pre-requisites for a more detailed study of the climate impact effects in forestry in Ukraine. At the present time, the necessity exists to conduct climate impact studies at a new methodological level, with the use of new scientific and statistical data, simulations, knowledge and experience, obtained during the previous years.

The existing plans for scientific research in Ukraine include the study of separate aspects of climate change effects in the forestry sector, but thus far there are no complex scientific research programmes on issues of climate change impact on forest ecosystems and on the forestry of Ukraine. Separate studies on this issue are insufficiently coordinated and are poorly linked with other work in this area being conducted at international level.

In order to reinforce research on the issues of climate change in the forestry of Ukraine, a complex programme is needed involving climate change impact studies on forest ecosystems and on the forestry sector, where the priority directions for the research should be determined clearly,

together with responsible executors and financing sources. The following are topics that might be considered a research priority:

- The development of methods and forecast simulations and scenario analysis of climate change impact on forest ecosystems and on forestry, by
 - improvement of the climate change forecast simulations methods for Ukraine and for its separate regions, the development of regionalization methods for global models for Ukraine (downscaling); and
 - improvement in the scenario analysis methods, the development of regional forecasts and climate change impact scenarios for forest ecosystems and the forest sector of Ukraine, based on empirical, statistical and numeric simulation and forecasting methods.
- The development of both land-based and remote forest inventory and monitoring for the improvement of information and the analytical forest management base in face of climate change. Activities would include
 - a complex inventory, monitoring and forest resources assessment programme, which should also be used for land-use changes and for obtaining regular integrated assessments of climate change effects;
 - scientific and methodological foundations should be developed as well as the methods and the technologies for national selective statistical inventory and for monitoring of Ukraine's forests through the use of remote Earth probing for the assessment of climate impact on the forests of the country and for measuring emission and absorption of GHGs in the forest sector;
 - applying modern GIS technologies to develop operational forest ecosystem mapping methods that could also be used for the development of digital maps of carbon reserves in forest lands; and
 - developing quantitative assessment methods of carbon build-up in forest ecosystems through the use of cutting-edge technologies over a network of representative monitoring sites in the national forests.
- The improvement of forest ecosystem vulnerability assessment methods during climate change, and the study of their adaptation capabilities. Activities could include
 - integral assessment methods developed to assess the effects of climate change on forest ecosystems, their productivity, biodiversity and role in ecological, economic and social functions;
 - a complex assessment of Ukraine's forest ecosystem vulnerability, performed during the climate change period, using of current forest statistics, improved models and scenarios; and
 - improvement in assessment methods for GHG emissions during wildfires.
- The justification and development of forest management adaptation strategies and of forest management measures for climate change impact mitigation, through:
 - the development of adaptation strategies and measures to mitigate the impact of climate change in the forestry of Ukraine;
 - improvement of the assessment methods of the sources and the absorbents of GHGs in the forests of Ukraine;
 - development of forest cultivation locations and forest restoration identification methods on the basis of mobile GIS and modern geographical positioning systems; and
 - development of recommendations on the organization and implementation of forestry projects, directed increasing carbon absorption in accordance with the flexible mechanisms of the Kyoto Protocol and the "green investments scheme", with due consideration for economic, ecological and social effects.

The execution of the abovementioned studies would serve as the basis for the development of cooperation between Ukrainian institutes and specialists and international research organizations and donors that support implementation of such projects (for example, FAO, UNDP, IPCC, GEF, World Bank, EBRD). Besides the research projects, such cooperation would support knowledge and technology exchange, the development of the potential for improvement of research opportunities (including technical assistance, transfer of modern technologies), improvement of awareness and communication capabilities. An important element would be support to seminars, training, conferences, thematic publications and the creation of Internet resources on climate change issues in forestry.

Information sources used

- Adamenko, T. 2007. Climate Conditions of Ukraine and Possible Outcomes of Climate Warming. *Agromedia*, 2007(1): 8–11.
- Adamenko, T.I. 2003. The Changes of the Heat and Moisture Supply of the Vegetation Period in Connection with Global and Regional Climate Warming in Ukraine. pp. 120–121, in: Thesis of the reports at the international conference, dedicated to the 70 year jubilee of the creation of Odessa state ecological University "Hydrometeorology and the Protection of the Environment 2002". Odessa.
- Anon. 2006. Second National Report of Ukraine on the Climate Change Issues. Interpress LTD. 80 p.
- Anon. 2004. Scientific Support of Constant Development of Agriculture in Forest Steppe of Ukraine. NAU. 456 p.
- Anon. 1998. First National Report on the Issues of Climate Change. Minprirody of Ukraine, ARENA-EKO. 61 p.
- Anon. 2004. Manual on methods and criteria for harmonized sampling, assessment, monitoring and analysis of the effects of air pollution on forests. United Nations Economic Commission for Europe, Convention on Long-Range Transboundary International Co-operative Programme on Assessment and Monitoring of Air Pollution Effects on Forests. Federal Research Centre for Forestry and Forest Products (BFH). 465 p.
- Barabash, M.B., Korzh, T.V. & Tatarchuk, O.G. 2004. The Study of Precipitation Changes at the Turn of the XX and XXI Centuries Under Conditions of Global Climate Warming. pp. 92–102. Scientific works of UkrNDGMI. Edition 253.
- Barabash, M.B., Korzh, T.V. & Tatarchuk, O.G. 2007. The peculiarities of Heat and Moisture Change in Ukraine during Present Day Climate Warming pp. 174–186, in: Scientific works of UkrNDGMI. Edition 256.
- Boichenko, S.G., Voloschuk, V.M. & Doroshenko, I.A. 2001. Global Warming and its Effects Over the Territory of Ukraine. *Ukrainian Geographical Journal*, 2001(3) 59–68.
- Bondarchuk, G.V. & Buksha, I.F. 2008. Certification of a Forest Management Enterprise: practical guide. vol. X. UkrNIILGA, KP, Printing house No. 13. 172 p.
- Boychenko, S.G. 2005. Global and Regional Climate Fluctuations (changes) and Their Probable Ecological Consequences on the Territory of Ukraine: Semi-empirical Simulations, Scenarios: Author's Abstract of the Dissertation for the Scientific Degree of Doctor of Science (PhD). 35 p in: *Metrology, Climatology, Agrometereology*. Odessa.
- Boychenko, S.G. & Naukova Dumka, K. 2008. Semi-empirical Simulations and Scenarios of Global and Regional Climate Change. 309 p.

- Buksha, I., Radchenko, O., Sidorov, A. and others. 1996. Air Pollution and Climate Change Effects on Health of the Ukrainian Forests: Monitoring and Evaluation. In: Air Pollution and Climate Change Effects on Forests Ecosystems: Abstracts. Riverside, California, USA.
- Buksha, I. & Pasternak, V. 2008. Prediction of carbon dynamics in forest ecosystems of Ukraine. pp. 37–41, in: Proceeding of the International Scientific Conference “Climate change and forest ecosystems”, 22–23 October 2008, Vilnius, Lithuania. Kaunas.
- Buksha I.F. 2009. Assessment of Ukrainian Forests Vulnerability to Climate Change. pp. 143–156, in: Regional Aspects of Interactions in Non-boreal Eastern Europe. Springer Science + Business Media B.V.
- Buksha, I.F. & Pasternak, V.P. 2005. The Opportunity for Joint Project Execution in Ukraine’s Forestry. pp. 92–93, in: Proceedings of an International Conference on SO Projects in Ukraine "Climate Change and Business".
- Buksha, I.F. & Pasternak, V.P. 2004. A Scenario Analysis and Long-term forecast for Ukraine’s Forest Resources as a Source of Renewable Energy. Wood business, 2004(1): 5–7.
- Buksha I.F., Butrim, O.V. & Pasternak, V.P. 2008. The Inventory of Greenhouse Gases at the Land Use Sector and in Forest Management. HNAU. 232 p.
- Buksha I.F. 2002. Contribution of Ukraine’s Forest Management to the Reduction of Climate Change Risk. pp. 132–148, in: Certain Aspects of Global Climate Change in Ukraine: a set of articles. The Initiative on Climate Change Issues.
- Buksha I.F. & Pasternak, V.P. 2005. The Inventory and Monitoring of Greenhouse Gases in Forest Management. I.F. Monograph. HNAU. 125 p.
- Buksha I.F. & Pasternak, V.P. 2003. Forest Cultivation on Lands, Which are Removed From Intensive Use and its Contribution to the Global Climate Change Risk Reduction. pp. 47–50, in: Collected scientific works of Agricultural Institute. No. 28.
- Buksha I.F. & Pasternak, V.P. 2004. Opportunities and Perspectives of Project Implementation of Joint Execution According to Kyoto Protocol in the Forestry of Ukraine. pp. 104–106, in: Collected scientific works of all-Ukraine ecological conference “Ukraine – the Year After the 5th All-European Conference of Ministers of the Environment “Environment for Europe”.
- Buksha, I.F., Pasternak, V.P. & Kornienko, V.P. 2002. The Role of Forestry in the Reduction of Climate Change Risk. Forestry and hunting magazine, 2002(1): 28–29.
- Buksha, I.F., Pasternak, V.P. & Bondarchuk, G.V. 2000. Scenario Simulation and Forest Resources Dynamics Forecast During Climate Change. Forestry and Agro-melioration, 98: 44–52.
- Buksha I.F. 2001. Scenario Analysis of Non-wearisome Forest Use At Different Forest Management Modes. Forestry and Agro melioration, 99: 37–41.
- Buksha I.F., Gozhig, P.F., Yemelyanova, Z.L. and others. 1998. Ukraine and Global Greenhouse Effect: Sensitivity and Adaptation of Ecological and Economical Systems to Climate Change Edited by V.V. Vassilchenko and M.P. Raptzun. Edition of the Agency for Rational Use of Energy and Ecology. 210 p.
- Buksha I.F. & Korniyenko, V.P. 2002. The Potential of Ukraine’s Forestry in the Execution of Joint Projects According to Kyoto Protocol. pp. 54–57, in: Investments and Climate Change: Opportunities for Ukraine: materials of international conference, 10–11 July 2002.
- Buksha, I.F. & Pasternak, V.P. 2001. The Forest Resources Dynamics Forecast During Antropogeneous Changes of the Environment. Naukovyj Vestnik NAU, 39: 157–162.

- Bun, P.A., Gusti, M.I., Dachuk, V.S. and others. 2004. Information Technologies for Greenhouse Gases Inventory and of Carbon Balance Forecast for Ukraine. Edited by P.A. Bunya. L'viv, Ukrainian Printing Academy. 376 p.
- Butrim, O.V., Buksha, I.F. & Pasternak, V.P. 2008. The Methodology of Emissions Assessment and Absorption of Greenhouse Gases in Soils on the Lands of Agricultural Business and Forest Management Designation. Report of Kharkov State Agrarian University series Land Study, Agro-chemistry, Agriculture, Forestry, 10(1): 227–231.
- Chorny, S.G., Tischenko, G.I. & Kuvavina, N.S. 2002. Present-Day Climate Changes in Kherson Region. Naturalist [Electronic resource]. See: proeco.visti.net/naturalist/ecology/clim.htm
- Didukh, Y. 2008. Global Climate Change: What Should Ecologists Do? Zerkalo Nedeli No. 43 (722) (15–21 November 2008).
- Didukh, Y. 2009. Ecological Aspects of Global Climate Change: Reasons, Consequences, Actions. pp. 34–44, in: Report of the National Academy of Sciences of Ukraine, 2009, no. 2.
- Dixon, R.K., Smith, J.B., Brown, S., Masera, O., Mata, L.J. & Buksha, I. 1999. Simulations of forest system response and feedbacks to global change: experiences and results from the U.S. Country Studies Program. Ecological Modelling, 122: 289–305.
- European Commission. 2006. Preparation of Joint Projects in Ukraine – Procedural and Methodological Aspects. Translated brochure of the European Commission “Technical Support for Ukraine and Belarus for Compliance With Their Obligations in the Sphere of Fighting Global Climate Change”. 36p.
- Gusti, V., Havlik, P. & Obersteiner, M. 2009. How much additional carbon can be stored in forests if economic measures are used and how much could it cost? National University of Bioresources and Management of Natural Resources of Ukraine. Scientific Report NUBiBiP of Ukraine / Forestry. Decorative Gardening, 135: 244–253.
- Holmgren, P., Marklund, L.-G., Saket, M. & Wilkie, M.L. 2007. Forest Monitoring and Assessment for Climate Change Reporting: Partnerships, Capacity Building and Delivery. Forest Resources Assessment Working Paper, 142. FAO, Rome.
- Ivanenko, N.P., Kaletnik, M.M., Kozelkovich, M.A. and others. 1997. Ukraine and Global Greenhouse Effect: Sources and Absorption of Greenhouse Gases. Edited by V.V. Vassilchenko and M.P. Raptzun. Edition of the Agency for rational use of energy and ecology. 96 p.
- Kaletnik, M.M., Buksha, I.F., Radchenko, O.M. & Sidorov, O.S. 1997. Environmental factors and State of Ukrainian forests: Monitoring and Impact Assessment. pp. 151–178, in: Restoration of forests: environmental challenges in Central and Eastern Europe. Proceedings of the NATO advanced research Workshop in Saulberg, Germany, July 1996. (NATO 2/30). Kluwer Academic Publishers, the Netherlands.
- Kiptenko, E.N. & Kozlenko, T.V. 2007. Assessment of Emissions and Absorption of Greenhouse Gases in Ukraine in the Sector “Changes of Land Use and Forestry”. Scientific Works of Ukr NDGMI, 256: 346–358.
- Kulbida, N. 2003. How Does Global Warming Threaten Ukraine [Electronic resource]. See: javot.net/virtual/1.htm
- Lakida, P.I., Buksha, I.F. & Pasternak, V.P. 2004. Reduction of Global Climate Change Risk Through Coal Deposits When Cultivating Forests and at Forest Management in Ukraine. Naukovy Vistnik NAU, 79: 212–217.
- Lakida, P.I., Buksha, I.F. & Pasternak, V.P. 2004. Perspectives and Directions of Forest Management Activity in Conjunction With Ratification by Ukraine of Kyoto Protocol and Framework Convention of the UN on Climate Change. Agrarian Science and Education, 5(3): 116–121.

- Lakida, P.I. 2002. Phytomass of Ukraine's Forests. Zbruch. 256 p.
- Lakyda, P.I., Buksha, I.F. & Pasternak, V.P. 2005. Opportunities for fulfilling Joint Implementation projects in forestry in Ukraine. *Unasylyva*, 56(3): 32–34.
- Lipinsky, V.M. 2002. Global Climate Change and its Impact on Climate Dynamics of Ukraine. pp. 177–185, in: *Investments and Climate Change: Opportunities for Ukraine. Proceedings of an International Conference, 10–11 July 2002.*
- Lipinsky, V.M. Dyachuk, V.A. & Babichenko, V.M. (editors). 2003. *Climate of Ukraine.* Rayevsky Publishing House. 345 p.
- Marhesinni, B., Perugini, L., Zibtsev, S., et al. 2009. Joint implementation projects: an opportunity for countries with economy in transition. National University of bioresources and management of natural resources of Ukraine. Scientific report NUBiBiP of Ukraine/Forestry. *Decorative gardening*, 135: 255–265).
- Meshkova, V.L. 2009. Seasonal Development of Acerose Leaf and Leaf-Eating Insects. *Planeta-print*. 396 p.
- Nijnik, M. 2002. Toward sustainability in forestry: The Ukraine's case. PhD thesis, Wageningen University, The Netherlands. 156 p.
- Pasternak, V.P. & Buksha, I.F. 2004. Methodological Approaches to Carbon Monitoring in Forest Ecosystems. *Management of Natural Resources, Ecological and Forest Politics*, 14(2): 177–181.
- Pasternak, V.P. & Buksha, I.F. 2003. Possibilities of Carbon Dynamics in the Forests of Kharkov Region Per Monitoring Data. *Vistnik HNAU*, 2003(2): 135–138.
- Pasternak, V.P. & Buksha, I.F. 2007. Justification of Activity Directions in the Land Use Sector and Forestry For Compliance With Kyoto Protocol Requirements in Ukraine. *Naukovyj Vistnik NAU*, 106: 124–134.
- Plyovyj, A.M., Adamenko, T.I., Kulbida, M.I. & Trofimova, I.V. 2007. Simulation of the Climate Change Impact on Agrarian-climatic Conditions of Growth and Photosynthesis of Winter Wheat. *Naukovy Zhurnal – Ukrainian Hydrometeorological Journal*, 2007(2): 76–92.
- Polevoy, A.N., Kulbida, N.I., Trophimova, I.V. & Adamenko, T.I. 2005. Simulation of Climate Change Impact on Shaping Productivity of Winter Wheat in Ukraine. In collected works: "The Issues of Ecological Monitoring and Ecosystem Simulation" Volume XX, Petersburg, *Gidrometeoizdat*.
- Polyovyj, A.M., Trofimova, I.V., Kulbida, M.I. & Adamenko, T.I. 2003. Assessment of Fluctuations of Winter Wheat Harvests in Ukraine According to Different Climate Change Scenarios. *Collection of Scientific Works. Ecology and Resources. Vol. 5* pp. 106–113.
- Romaschenko, M.I., Sobko, O.O., Savchuk, D.P. & Kulbida, M.I. 2003. On Certain Tasks of Agrarian Science in Conjunction With the Climate Change. Scientific report – information.
- Savuschikh, I., Popkov, M. & Savuschik, M.P. 2009. Recommendations for the Creation of Forest Plantations on the Agricultural Lands of Polesye Contaminated by Radionuclides for the Implementation of the BioCarbon Fund in Ukraine. pp. 131–134, in: National University of Bioresources and Management of Natural Resources of Ukraine. Also published as Scientific Reporter NUBiBiP of Ukraine, in *Forestry, Decorative Gardening*, vol. 135.
- Schelhaas, M.-J., Buksha, I., Cerny, M., Pasternak, V. et al. 2004. Scenarios on forest management in Czech Republic, Hungary, Poland and Ukraine. European Forest Institute Research Report No. 17. Brill, Lieden–Boston. 107 p.
- Seppälä, R., Buck, A. & Katila, P. (editors). 2009. Adaptation of Forests and People to Climate Change. A Global Assessment Report. IUFRO World Series, Volume 22. Helsinki. 224 p.

- Sitnik, K. & Bagnjuk, V. 2006. Biosphere and Climate: The Past, The present And The Future. Report of the National Academy of Sciences of Ukraine, 9: 3–20.
- Shevchuk, V.Y., Trofimova, I.V., Trofimchuk, O.M. and others. 2001. Problems and Strategy of Execution of Framework Climate Change Convention of the UN. Edited by V.Y. Shevchuk. UINSiP. 96 p.
- Shevchuk, V.Y., Ivanenko, N.P., Kublanov, S.H. & others. 2005. Global Climate Change: Economic and Legal Mechanisms of Kyoto Protocol Implementation in Ukraine. Edited by V.Y. Shevchuk. Geoprint. 150 p.
- Shvidenko, A. 2009. Non-boreal Forests of Eastern Europe in a Changing World: the Role in the Earth Systems. pp. 123–133, in: Regional Aspects of Interactions in Non-boreal Eastern Europe. Springer Science + Business Media B.V.
- Sidorov, A., Radchenko, O., Buksha, I. & Meshkova, V. 1997. GIS in a study of potential climate changes effects on forests. pp. 1541–1548, in: Proceedings 18th ICA/ACI International Cartographic Conference, Stockholm, Sweden.
- Trofimova, I., Koublanov, S., Shmurak, E., Buksha, I. and others. 1996. Vulnerability and Adaptation Assessments for Ukraine. In: Vulnerability and Adaptation to Climate Change. Kluwer Academic Publishers, the Netherlands.
- Voloschuk, V.M. & Boichenko, S.G. 1998. 1998. Impact of global warming on annual average intensity of atmospheric precipitations in Ukraine. Scientific bulletin of NAS, 6: 125–130.
- Vorobjov, D.V. 1960. Forest Typology Climate Classification. pp. 235–260, in: Works of Kharkov Agricultural Institute.
- Yeremeyev, V. & Yefimov, V. 2003. Regional Aspects of Global Climate Change. Vistnik NAN Ukraine, 2003(2): 22–26.

Climate change-related Laws and Regulatory Documents

- Law of Ukraine dated 29.10.1996 No. 435/96-VR “On ratification of the Framework Climate Change Convention of the UN”.
- Law of Ukraine dated 04.02.2004 No. 1430-IV “On ratification of the Kyoto Protocol to the Climate Change Convention of the UN”.
- Decree of the President of Ukraine dated 12.09.2005 No.1239/2005 “On Coordination of the measures for the enforcement of obligations of Ukraine under the Kyoto Protocol and the Framework Climate Change Convention of the UN”.
- Order of the Cabinet of Ministers of Ukraine dated 18.08.2005 No. 346. "National action plan for implementation of the provisions of the Kyoto Protocol and the Framework Climate Change Convention of the UN”.
- Order of the Cabinet of Ministers of Ukraine dated 05.03.2005 No. 272. "On amendments to the national action plan for implementation of the provisions of the Kyoto Protocol and the Framework Climate Change Convention of the UN”.
- Decree of the Cabinet of Ministers of Ukraine dated 14.04.1999, No. 583 “On interdepartmental Commission on execution of the previsions of the Framework Climate Change Convention of the UN”.
- The Decree of the Cabinet of Ministers of Ukraine dated 22.02.2006 No. 206 “On the approval of the consideration, approval and implementation of projects, directed at the reduction of anthropogenic emissions or increased absorption of greenhouse gases according to the Kyoto Protocol and the Framework Climate Change Convention of the UN”.
- Decree of the Cabinet of Ministers of Ukraine dated 10.04.2006 No.468 “On the order of coordinating measures for the execution of obligations of Ukraine under the Kyoto Protocol and the Framework Climate Change Convention of the UN”.

- Decree of the Cabinet of Ministers of Ukraine dated 21.04.2006 No.554 “On approval of the order of assessment system functioning for evaluation of anthropogenic emissions and absorption of greenhouse gases that are not regulated by the Montreal protocol on substances, which destroy the ozone layer”.
- Order of the Ministry of Environmental Protection of Ukraine dated 01.06.2006 No.273 “On approval of methodological recommendations for preparation and submission for approval of projects jointly executed by legal entities”.
- Order of the Ministry of Environmental Protection of Ukraine dated 17.07. 2006 No. 341 “On approval of requirements to the documents, which substantiate the volumes of anthropogenic emissions and greenhouse gases absorption for issuance of a letter of support to the owner of such emissions where the joint project implementation is planned”.
- Order of The Ministry of Environmental Protection of Ukraine dated 17.07.2006 No. 342 “On approval of requirements for jointly executed projects”.
- Decree of the Cabinet of Ministers of Ukraine dated 4.04.2007 No. 612 “On establishment of National agency for ecological investments of Ukraine”.
- On approval of the Instruction on joint project execution under the national procedure / Order of the National agency for ecological investments of Ukraine dated 18.12.2008 No. 79 (Registered in the Ministry of Justice of Ukraine on 16.01.2009 N 27/16043).
- Decree of the Cabinet of Ministers of Ukraine dated 13.09.2002 No. 1371 “On the order of participation of central bodies of executive power in the activity of international organizations where Ukraine is a member”.
- Decree of the Cabinet of Ministers dated 10.04. 2006 No. 468 “On the order of coordinating activities for execution of obligations of Ukraine under the Framework Climate Change Convention of the UN and the Kyoto Protocol to the mentioned convention (as amended, according to decree KM No. 392 dated 17.04 2008).”
- Decree of the Cabinet of Ministers dated 21.04. 2006 No. 554 “On approval of the Order of the national system functioning for the assessment of anthropogenic emissions and absorption of greenhouse gases, which are not regulated by the Montreal protocol on substances that destroy the ozone layer (as amended according to the Decree KM N 392 (392 – 2008 – p) dated 17.04.2008)”.
- Decree of the Cabinet of Ministers dated 30.07. 2007 N 977 “On approval of Provision on National agency for ecological investments of Ukraine" (as amended, according to the Decree KM N 392 (392-2008-p dated 17.04.2008).
- Decree of the Cabinet of Ministers dated 22.02. 2008 N 221 “On approval of the Order of consideration, approval and implementation of projects of target ecological (green) investments during the validity terms of the Kyoto Protocol and of the Framework Climate Change Convention of the UN” (as amended, according to Decree KM No. 642 (642 – 2008 – p) dated 16.07.2008).
- Decree of the Cabinet of Ministers dated 17.04. 2008 N 392 “On Ukraine’s international obligations enforcement under the Kyoto Protocol and the Framework Climate Change Convention of the UN”.
- Decree of the Cabinet of Ministers dated 28.05. 2008 N 504 “On the establishment and maintenance of the National electronic registry of anthropogenic emissions and greenhouse gases absorption”.
- Decree of the Cabinet of Ministers dated 16.07. 2008 N 642 “On amending the Order of consideration, approval and implementation of target ecological (green) investment projects during the validity terms of the Kyoto Protocol and of the Framework Climate Change Convention of the UN”.

Order of National agency for ecological investment of Ukraine dated 25.06. 2008 No. 32 “On approval of requirements to the documents, which substantiate the volumes of anthropogenic emissions and greenhouse gases absorption for issuance of a letter of support to the owner of such emissions where the joint project implementation is planned”. (Registered in the Ministry of Justice of Ukraine on 17.07.2008, N 664/15355).

Order of National agency for ecological investment of Ukraine dated 25.06. 2008 N 33 “On the approval of the Requirements for the preparation of joint execution projects” (Registered in the Ministry of Justice of Ukraine on 17.07 2008 N 665/15356).

Fifth National Report of Ukraine on the Climate Change Issues (Draft). 2009. Ministry for the Protection of the Environment of Ukraine, Ministry of Emergency situations and on the population protection against Chernobyl accident consequences, National Academy of Sciences of Ukraine, Ukrainian Scientific and Research Hydrometeorological Institute. 282 p.

Appendix No. 1. National legislation and regulatory documents on climate change issues

The Supreme Council (Parliament) of Ukraine ratified the UNFCCC on 29 October 1996, and in accordance with UN rules, Ukraine became a Party to the Convention on 11 August 1997. The Kyoto Protocol to UNFCCC was ratified by Ukraine on 4 February 2004.

The national regulatory and legislative base, related to the climate change issues is constantly developing and improving. To date, the Government and state administration bodies have adopted about 30 regulatory and legislative documents, dealing with the execution of the requirements of UNFCCC and its Kyoto Protocol, which regulate activity in Ukraine, related to climate change issues.

By Decree of the Cabinet of Ministers of Ukraine dated 14.04.1999, No. 583, an interdepartmental commission was created for enforcement of UNFCCC. The representatives of the Cabinet of Ministers of Ukraine, of the Supreme Council of Ukraine, of the secretariat of the President of Ukraine, of ministries and departments, and of the National Academy of Science of Ukraine are part of this commission. A number of special Government decrees were adopted with the purpose of coordinating execution of Ukraine's obligations under UNFCCC and its Kyoto Protocol. The Decree of the Cabinet of Ministers of Ukraine, dated 18 August 2005, is an important government document in the context of climate change issues, No. 346, which approved the National plan of activities for the implementation of Kyoto Protocol provisions (this plan was amended by order of the Cabinet of Ministers of Ukraine dated 5 March 2009, No. 272). The national activity plan for the Kyoto Protocol provisions implementation is directed at addressing the following tasks:

- Improvement of the national GHG emission and absorption assessment system.
- Preparation and timely submission to UNFCCC Secretariat of GHG emission and absorption reports.
- The creation of favourable conditions to implement the "flexible mechanisms" of the Kyoto Protocol in Ukraine.
- The creation of a national GHG emission and absorption reporting system.
- The development of regulatory and legislative documents for GHG emission and absorption quantity regulation.
- Establishing a GHG emission units forecast for the period to 2012.
- Maintaining databases for joint execution of projects.
- Preparation and publication of national reports on climate change issues.
- Development of National plans on adaptation and climate change impact mitigation.
- The participation of Ukraine in UNFCCC Conferences of the Parties.

- Evaluation of GHG emission reduction potential to 2020, strategic forecast and the assessment of climate change impact on various economy sectors, on the population and ecosystems.
- Creation of a data bank on ecologically safe technologies that allow reducing emission volumes and increasing GHG absorption volumes.
- Implementation of measures on training and qualification improvement within the scope of UNFCCC and its Kyoto Protocol, for State employees, preparing personnel, and informing the public on climate change issues.

According to many experts, the State legislation and the existing regulatory basis for climate change issues creates good pre-requisites to reach the goals set by UNFCCC and its Kyoto Protocol. Detailed information on national legislation and on regulatory documents on climate change issues can be found at:

- www.menr.gov.ua/cgi-bin/go?node=ZAK%20baza%20UN
- neia.gov.ua/nature/control/uk/publish/category;jsessionid=667AC1E80076F4673EF6F83AAC2DCC69?cat_id=108499
- www.informkioto.org.ua/main/ua/258.htm

Appendix No. 2. Climate change in Ukraine: empirical data and forecasts

Climate observations in Ukraine started in the 18th century, and significant empirical material was accumulated during the period of such instrument-based observations, as well as providing long-term data on various climatic system indicators. The Ukraine Climate Cadastre was formed in the 1990s and holds information on meteorological data. The Decree of the Cabinet of Ministers of Ukraine No.650 dated 28 July 1997 approved “The Climate Programme of Ukraine”, that stipulates how the climate monitoring system should be conducted, as well as the use of the information obtained for multiple purposes.

The results of the climate dynamics study in Ukraine during the period of instrument-based observations show that global climate change tendencies manifest themselves in regional specifics of Ukraine’s climate. According to the data of the Hydrometeorological Centre over the last hundred years, the average yearly temperature in Ukraine has increased by about 1°C, while on average the temperature on this planet during the same period has increased by 0.6°C. This warming of the national territory manifests itself rather incoherently. Near the ground, temperatures have increased in those locations in those months that were previously cold, and the near-ground temperature in locations with higher temperatures has practically not changed. Ukraine’s climate warming shows a similar pattern to global trend parameters, with an increase 0.4–0.6°C over 100 years. This warming is characterized by the heterogeneity (non-monotonicity) of the near-ground temperature increase. Periods of significant temperature increases have been followed by periods of decrease. During this 100-year period, the most pronounced temperature increase trend was noted in the northeastern part of Ukraine (about 1°C); in the northwestern and central parts this trend amounted to 0.7–0.9°C; while in the southern part it was 0.2–0.3°C. The most intensive temperature increase was noted during winter (1.2°C) and spring (0.8°C), while the summer temperature increase amounted to 0.2–0.3°C.

Precipitation over the last 100 years showed precipitation distribution levelling-off. In those regions where precipitation was insignificant (southeast of the country), precipitation increased by about 15%, and in the regions with greater precipitation (northwest) precipitation decreased by about 5%. During this process there was a decrease in the climate's continentality and more occurrences of extreme weather events (rainstorms, floods, unseasonal thawing, early frosts, and squalls).

More significant temperature changes were observed in particular regions of the country. According to Yeremeyev and Yefimov (2003), for the period from 1961 to 1996, statistically the average air temperature increased considerably in the northwestern and southeastern subregions

of Ukraine, by 2.7–7.8°C, and in the northwest by 1.0–1.7°C. Because of the air temperature increase, the number of days with subzero temperatures decreased by 5–10%. Air humidity increased considerably, by 10–25%. As the analysis of the statistically extreme events showed, the re-occurrence of anomalously high average monthly temperatures before the end the 20th century increased two- to three-fold in comparison with the beginning of the century, and the number of anomalously cold winters decreased.

According to the climate indicators analysis, Ukrainian climatologists came to the conclusion that a new climate was being formed in Ukraine: the winters became less cold and had little snow, and the summer became colder. Sometimes sharp air temperature falls occur, by up to 10–12°C in a 24-hour period. During such periods, as a rule, atmospheric disturbances appear, as well as extreme events (rainstorms, thunderstorms, hail, strong winds, hurricanes, etc.). In the future, anomalously cold winters are forecast, with abrupt temperature falls and, with a lack of snow cover, droughts can be expected.

During the period of instrument-based observations, atmospheric precipitation in Ukraine did not significantly change, but the intensity of did change. The data show 11, 22, 28 and 30-year periods of increased and decreased moisture modes. Precipitation for Ukraine in general increased by 20–50 mm in winter, but in the western part of the country it decreased by 20–30 mm. In the spring, precipitation increased by 10–20 mm and remained without change in certain areas. The precipitation neither changed nor decreased in summer: in the west by 40–50 mm, in the east and southeast by 10–30 mm and in the Crimea by 20–35 mm. Precipitation in autumn in the west of the country, decreasing by 40–50 mm, and in the centre and south of Ukraine it increased by 10–20 mm. Territorially, precipitation changed: in the northern and western regions and in the Crimea annual precipitation decreased by 50–100 mm; and in the east by 10–30 mm. There were virtually no changes observed in precipitation on the Azov sea coast (northeastern part of the country). It can be concluded that there are no clear trends obvious in precipitation distribution characteristics in time and space.

Regional precipitation change analysis for the south showed that there was increased precipitation in the Kherson region during the last decade, causing a transformation of the water balance of the territory and increased negative events, such as erosion, soil salinization and inundation. Certain positive climate change effects were also noted in this region: there was increased productivity of the agricultural land due to the increased moisture.

It is rather difficult to forecast temperature changes for the middle latitudes, as the forecasts of probable precipitation amounts and air temperature change are vague. It is even more difficult to forecast climate change impact on natural ecosystems, as both positive and negative effects may manifest themselves. For example, several researchers forecast that more favourable conditions are being formed for winter wheat as a result of the climate change. However, many specialists in the agrarian sector believe that the climate changes will lead in general to deterioration in agricultural crop growth conditions.

Different climate change forecasts for eastern Europe show that the main climate change tendencies in the future will be linked to the temperature increase and to precipitation decreases, and, as a consequence, will lead to increased aridity. The comparison of today's climate indicators (for the period 1950–2000) with the climate indicators forecast to 2020 led to the following conclusions for Ukraine:

- The temperature will increase considerably all over the country, especially in its southern part. The yearly average temperature will increase by 20% (from 7.5°C to 9.0°C). A similar trend is expected for the day temperatures during the growth period (April–September).

- Total precipitation will decrease on average for the year and in the growing period, especially in the southern part of the country.
- Changes will occur in the natural zones, in particular there will be expansion of the mixed forests zone (Polesye) and the formation of semi-desert zone in the southern part of the country when warming increases by 2–3°C.
- There could be catastrophic desertification of Ukraine’s southern regions (if the global warming level exceeds 3–4°C), which will intensify erosion processes, lead to depletion of freshwater resources, and decreased precipitation.
- The levels of the Black and Azov seas will rise.
- There will be a potential demographic crisis, with intensification of migration processes.

According to the forecasts, obtained with the help of regional digital simulation of atmospheric circulation and semi-empirical climate change simulation and the GHG emissions scenarios, by 2050 the average regional near-ground temperature may increase by 1.5–2.0°C, in January by 2.0°C in the south of the country, by 2.8°C in the north and on average for the country it will increase by 0.5–1.0°C in July. As far as precipitation is concerned, after 2040 a certain increase in precipitation is forecast during the winter period and the summer precipitation will be within the historical norms, but extreme events can be expected to occur.

Appendix No. 3 – International cooperation of Ukraine on climate change issues

Ukraine cooperates with many countries and with many international organizations on climate change issues. One of the first international cooperation projects on climate change studies in Ukraine was the US Country Studies Program, a programme dedicated to climate change studies in developing countries and in countries with economies in transition (www.gcrio.org/CSP/webpage.html). This programme started in Ukraine in 1994 and a complex study of the climate change issues for Ukraine’s ecosystems and economy was conducted, including research on climate change impacts on national forests and forestry.

On 28 January 1999, a Memorandum of Cooperation on climate change issues was signed between the Government of Ukraine and the Government of Canada. A second Memorandum of Understanding between the Government of Ukraine and the Government of Canada on cooperation on climate change issues, including projects executed according to Article 6 of the Kyoto Protocol, was signed on 7 December 2005 in Montreal. The Canadian-Ukrainian ecological cooperation programme was executed in 1999–2003. Several studies were performed within the framework of this programme on UNFCCC implementation issues, on joint execution of projects, on GHG monitoring and inventory systems, and on mitigation of climate change impact (www.climate.org.ua/canada/Can_Webua.html).

On 8 December 1999, a Memorandum of Cooperation on climate change issues was signed between the Government of the United States of America and the Government of Ukraine. With the support of the international development agencies of the United States of America and Canada in 1999–2003, Ukraine launched a centre on “Initiative on Climate Change Issues”. The activity of this centre was directed at providing assistance to Ukraine in the execution of its obligations under UNFCCC, the development of climate preservation policies, assistance in the search for investments for projects, aimed at GHG emission reduction and at increasing absorption of GHGs (see www.climate.org.ua/index.html). With the purpose of preparing the projects on absorption of GHGs within the framework of the Initiative, several educational modules on “Carbon Absorption in Agriculture” were developed, experts in different regions of the country were trained, and several project proposals were prepared for activities in the forest centre, aimed at reducing GHG emissions and at increasing their absorption.

In 2001–2003, within the framework of the joint programme of the World Bank and Switzerland, “The National Strategic Study in Ukraine on Joint Execution” project was developed. This project’s objective was the development of analysis of international GHG emission reduction instruments via joint execution mechanisms for the state organizations. Several joint execution projects were identified in the forest sector of Ukraine.

In 2001, the Joint Workgroup for the identification of cooperation opportunities on global climate change issues was created within the framework of partnership and cooperation between Ukraine and the EU. This Workgroup exchanges information on activities on climate change issues carried out in Ukraine and in the EU; this group coordinates the efforts of Ukraine and the EU on execution of their obligations under UNFCCC and the Kyoto Protocol.

As a result of cooperation with the European Commission, from May 2004 to October 2006 a project was executed: “Technical support for the process of obligations execution by Ukraine and Belarus in the sphere of reducing global climate change impact” (www.climate-change-ukraine.info). Works under this project was directed at the creation of organizational and technical potential for the participation of Ukraine and Belarus in UNFCCC and the Kyoto Protocol.

On 20 May 2003, a Memorandum of Cooperation on UNFCCC execution issues was signed between the governments of Ukraine and Denmark. On behalf of Ukraine this Memorandum was signed by the Minister of the Environment (Minprirody) of Ukraine and on behalf of Denmark by the Minister of Ecology of Denmark. The forestry potential of Ukraine was assessed within the framework of this cooperation. The GHG emissions unit reduction was also investigated. The scientific and methodological principles were developed for data gathering and preparation, where this data will be used for national reporting purposes under UNFCCC and the Kyoto Protocol.

In 2004, a Memorandum of Understanding was signed between the Ministry of the Environmental Protection (Minprirody) of Ukraine and the UNDP on cooperation on climate change issues. Several issues of Ukraine’s forest sector adaptation were studied within the framework of this cooperation.

A Memorandum of Cooperation was signed on 7 June 2006 between the Government of Ukraine and the Kingdom of the Netherlands on issues of UNFCCC and Kyoto Protocol execution, in particular on GHG emission reduction according to Article 6 of the Kyoto Protocol.

On 15 March 2007, an agreement was signed in Paris between the Government of Ukraine and the French Republic on cooperation in the execution of joint projects according to the Kyoto Protocol.

On 14 June 2008, A Memorandum of Cooperation was signed between the Government of Ukraine and the Government of Japan on assistance in the execution of the UNFCCC and the Kyoto Protocol in accordance with Articles 6 and 17 of the Kyoto Protocol. Within the framework of this Japan-funded project a website was created: "Public information on Kyoto Protocol Implementation" (www.informkioto.org.ua/main/ua).

On 11 December 2008, a Memorandum was signed between the Ministry of the Environment, Agricultural and Maritime Issues of Spain and the National Agency of Ecological Investments of Ukraine on activities related to Articles 6 and 17 of the Kyoto Protocol.

In March 2009, the Federal Ministry of the Environment, Environmental Protection and Security of Nuclear Installations of Germany invited the Ministry of Environmental Protection (Minprirody) of Ukraine to participate in a climate protection initiative that supports projects

related to the development of natural reserves, which unambiguously create a positive impact on the climate.

On 18 June 2009, a Memorandum was signed between the Ministry of the Environment of Italy and the National Agency on Ecological Investments of Ukraine on issues of joint project implementation under the Kyoto Protocol.

An information centre was created in Ukraine with support from the British Council on climate change issues. This centre takes care of issues of informing the public, developing cooperation and supporting climate protection activities (www.climateinfo.org.ua).

The scenario analysis and forecast for Ukraine's forest sector during climate change were performed within the framework of an international "Scenario Analysis of Sustainable Wood Production under Different Forest Management Regimes – SCEFORMA" project that was conducted within the framework of the EC INCO-Copernicus research programme (www.efi.int/portal/research/projects/?todo=3&projectid=129).

UZBEKISTAN

Evgeniy Botman

Summary of climate change dimensions

There is no scientifically based information in recent decades on observations of the effects of climatic change experienced in forest stands, such as yield and vitality decline, or increased mortality. This reflects features of scientific grant distribution as well as the current situation forest science. The only activity in this direction was made within the framework of National Communication reports on climate change.

Acknowledging the importance of the climate change problem and the need to take rapid measures on mitigation of its consequences, Uzbekistan signed the UNFCCC in 1993 and ratified the Kyoto Protocol in 1999.

Government of the Republic of Uzbekistan entrusted the Centre of Hydrometeorological Service (Uzhydromet) at the Cabinet of the Ministers with functions of realizing obligations under UNFCCC. In accordance with its obligations, Uzbekistan presents to UNFCCC data on:

- National conditions and peculiarities of the country.
- National GHG Inventory.
- Forecasts of GHG emissions.
- Emission reduction potential assessment and necessary measures.
- Climate observation systems and climate research information.
- Climate change consequences assessment and possible means of adaptation.
- Public awareness on climate change problems.
- Possible strengthening for UNFCCC obligations fulfilment in Uzbekistan.

As do other country signatories to UNFCCC, Uzbekistan realizes projects directed to fulfilling its obligations under the Convention. The first step towards fulfilment of the obligations was the project “Uzbekistan – country study on climate change” with GEF and UNDP support. The First National Communication of the Republic of Uzbekistan under UNFCCC was prepared and presented in 1999. The Second National Communication was presented in 2008.

All activities related to the influence of global warming on forestry have been started and continue to be implemented in the framework of preparation of the national communications of Uzbekistan on climate change. Uzbekistan submits regularly its national reports on forestry to UNFCCC (see: unfccc.int/resource/docs/natc/uzbnc1.pdf) and FAO (see www.fao.org/forestry/webview/media?mediaId=8859&geoId=170). To date, two such Communications have been developed: in 1999 and 2008. These communications contain information about the country’s forestry.

Brief description of forestry in Uzbekistan

The total land area of the State forest fund of the Republic of Uzbekistan at the beginning of 2009 included 8 661 200 ha, or about 19.5% of the national territory, within which the forest-covered area was 7.3%. The forestry fund comprises forest lands, i.e. lands intended for afforestation, and non-forest lands, where afforestation requires additional reclamation. Forest lands include categories such as forest-covered areas, open artificial plantings, sparse forests, fire sites, perished stands, cut sites, groves and abandoned sites. Non-forest lands include arable lands, hayfields, pastures, marshes, sands and other lands.

Correspondingly, based on topography, soil and climatic conditions, the country's forests (forest-covered areas) are divided into mountain forests, floodplain valley forests, and desert forests. The greatest distribution (78%) is of aridity-tolerant species, such as saxaul (*Haloxylon persicum* Bge. and *H. aphyllum* Hjin.), salwort (*Salsola richleri* (Moq.) Kar. ex Litv., *S. paletziana* Litv.), *Calligonum* spp., and other desert-type forest vegetation.

In mountains coniferous species (juniper) occupy 11% of all the forest area of Uzbekistan, whereas nuciferous and wild fruit trees ones occupy 2.8%. Juniper forests of Uzbekistan are formed three species (Sabina section): *Juniperus seravshanica* Komar, *J. semiglobosa* Rgl. and *J. turkestanica* Komar. *Tugays* (flood-plain forests) occupy floodplains and river deltas periodically flooded. These are typically oleaster (*Elaeagnus angustifolia* L.), *turanga* (*Populus euphratica*) and tamarisk (*Tamarix* spp.). They occupy about 5% of the forest area.

The forest-covered area is distributed unevenly across Uzbekistan, with 80% of forests in Karakalpakstan, Navoi and Bukhara regions, and less than 1% of forests in Sirdarya, Samarkand and regions of the Fergana valley altogether.

The forest productivity of Uzbekistan is very low. The forest stocking density per hectare of mature and over-mature forests on average is ca 6 m³, with coniferous forests at 29 m³, hardwoods only 6 m³, and saxaul forests at about 3 m³. It is quite obvious that this is associated with the general aridity. Nevertheless, all forests of Uzbekistan have huge protective importance. In addition, these are sustainable ecosystems (in the absence of anthropogenic impacts), highly adapted to specific soil-climatic conditions, including to natural climatic fluctuations.

In the mountains they prevent erosion and mudflow processes, convert surface water flow into interflow and expand the debit of the rivers. In deserts, forest stands mitigate conditions of habitat, fix mobile sands, and protect economic objects from sand covering, serve as local sources of fuelwood, and increase productivity of desert pastures. In floodplains, the tugai forests perform a bank and water protection role, and provide casewood. In irrigated plain lands, the forest stands serve as protection from injurious action of water and wind erosion, and hot dry winds.

The forests are the source of non-wood forest products, including nuts (walnut, pistachio, almond), fruits (apple, pear, cherry-plum, apricot, hawthorn, barberry), mushrooms and berries, herbal medicines, tanning and dyeing agents. Forests are the basis for maintaining biological diversity of the fauna and flora.

Inventory of GHG emissions and sinks

Emissions and sinks of CO₂ were calculated by applying the LULUCF module to the lands of the State Forest Fund. The State inventory of the forest fund is undertaken every five years, based on forest regulation materials for forestry farms, which is undertake in nature once every ten years. It is obvious that updating of the GHG inventory is also undertaken once in five years with this module. The values of sinks and emissions in the following four years are taken as equivalent by default. The whole further calculation is carried out for forest-covered areas of the State Forest Fund. Inventory of emission and absorption of GHGs in the forestry sector has been undertaken based on the IPCC Guidelines for effective practice for the LULUCF sector. The table below shows the calculated annual change in carbon reserves, based on methodologies for 1996 and 2006.

Table 1. Calculation of annual change of carbon reserves in living biomass of the forestry sector.

Inventory year	Methodology	Forest area	Annual increase in carbon reserves (t C/year)	Annual decrease in carbon reserves (t C/year)	Annual change in carbon reserves (Gg CO ₂ /year)
1998	1996	3 033.5	—	—	758.0
2003	1996	2 327.3	171.7	18.3	562.5
2003	2006	2 327.3	387.5	30.2	1310.0

Assessment of climate change impact on forests of Uzbekistan

In order to assess the climate change impact on forest ecosystems, an empirical biophysical model was applied, assessing conditions of natural habitats of tree or shrub species based on the totals of positive average monthly temperatures and precipitations during the warm period of the year with existing and changing climate. The climate change impact on basic forest forming species of mountain (juniper), flood-plain-valley and desert (saxaul) forests of the country was assessed.

Vulnerability assessment

Desert forests

The desert forests of Uzbekistan account for about 78% of all forest-covered area of the country. Saxaul forests, as the main forest forming species of desert forests, account for 67% of all these forests. Expected climate conditions in the deserts of Uzbekistan will be hotter and dryer, but new agricultural meteorological indices in saxaul natural habitat do not go beyond the limits of accepted climatic habitat limits of these species. The habitat conditions become more arid (especially in 2080), i.e. the general climate of area within the country's limits becomes warmer, dryer and characterized by smaller fluctuation of climatic indices, but these climatic changes will not have a significant impact on condition of saxaul stands. However, it is obvious that such conditions may result in a decrease in productivity and deterioration of saxaul stands. Similar conclusions apply for other shrub species growing in the deserts of Uzbekistan, as they are distributed on the common territory.

Flood-plain and valley forests

These include forest plantations on irrigated and conditionally irrigated lands, protective forest plantings on agricultural lands and tugai forests (flood-plain forests). Forest plantations are often protective forest plantings on agricultural lands and are artificially created stands. In the conditions of Uzbekistan, these stands can grow only on irrigated or conditionally irrigated lands. The main factor limiting the growth of forest stands here is access to moisture, which is assured or not assured by human intervention. Therefore, their state depends mainly not on possible climate warming but on maintenance activities and irrigation. Tugais occupy periodically inundated flood-plains. Remains of tugai vegetation can be also observed along modern riverbeds on surface terraces, if they are flooded from time to time. In the depth of the desert in old river zones there are remains of degraded tugai vegetation, where moistening of soil currently depends only on precipitation. Vulnerability of tugais is not so much due to changing air temperature and precipitation, but rather uncontrolled felling due to easy access to these plantations, uprooting with the purpose of agricultural reclamation of flood lands, lack of high waters in natural terms due to overregulation of river run-off (regulated flow), lowered groundwater levels, etc.

Mountain forests

Based on the example of the well studied mountain juniper formations, the situation with other forest formation species in this zone during climate change can also be estimated. In general, the

climatic factor combinations for areas favourable for juniper growing will be shifted toward dryer and colder climates. The boundary of cold dry climate will be shifted much less than the boundary of warm humid climate. The more unfavourable becomes the combination of increasing temperature and changing precipitation due to possible climate change, the more constricted becomes the area of preferred habitat of juniper, especially by 2080 (Figure 1). The hypsometric level of juniper formation boundaries will rise. The hypsometric level of the lower boundary of zeravshan junipers (*Juniperus seravshanica* Komar.) will rise by more, 1000 to 1050 m, e.g. in 2080 under the A2 scenario. The hypsometric marks of the upper boundary of zeravshan junipers will rise by smaller values, 800 to 900 m, semi-globular junipers (*J. semiglobosa* Rgl.) by 650–750 m, and the upper boundary of turkestan juniper (*J. turkestanica* Komar.) by 500–650 m.

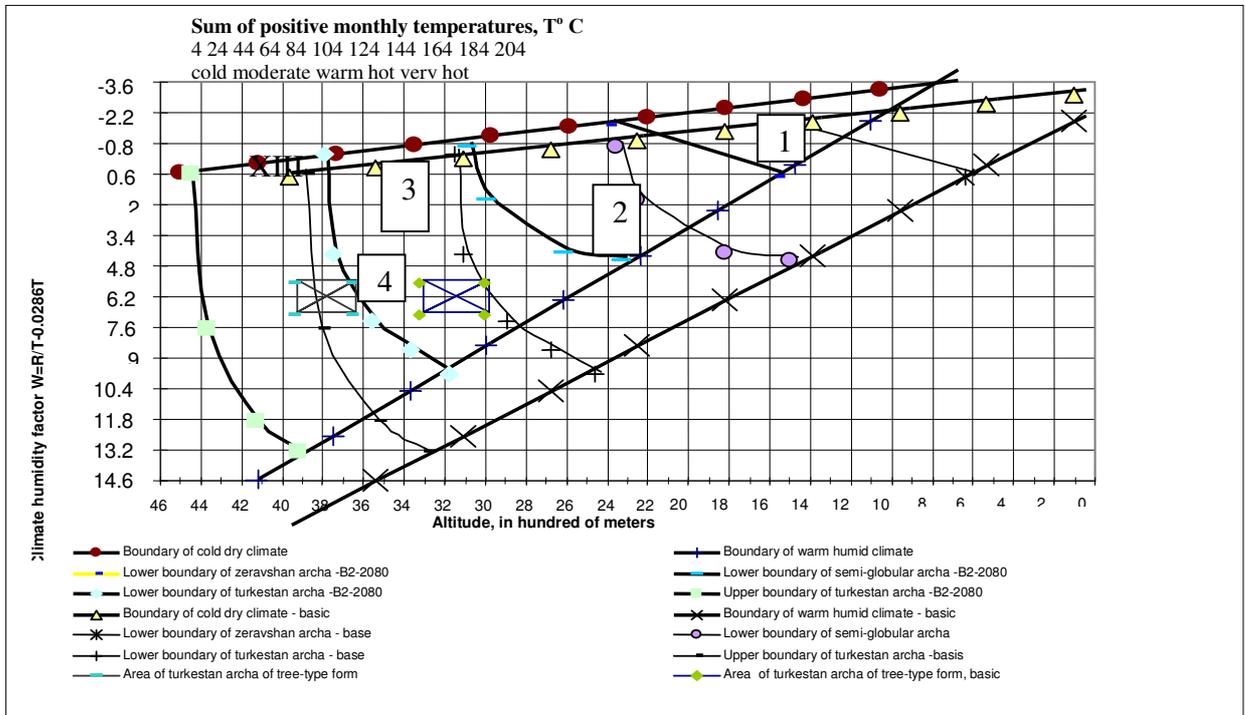
The term boundaries implies changes in the boundaries of possible favourable zones for the entire juniper forests in Uzbekistan. Certain forest planting districts may have greater amplitudes. The outcome of such a shift in juniper growing zone boundaries will be reduction in the breadth of the juniper belt. Moreover, the elevation belt of lowland formations will reduce by more in comparison with highland stands. In general, according to true altitude, the juniper belt extent will decrease by 350 m (2080, A2 scenario). This, naturally, will also reduce the whole area with conditions favourable for juniper stands. It can also be assumed that this area will contract because the higher the hypsometrical level of the soil surface, the smaller its area. In addition, increasing altitude above sea level results in substantial worsening of soil conditions as there is more coarse material, stone screes, shallow soils, etc. This, in turn, will substantially reduce productivity of woodlands in new habitats and complicate work for their establishment.

Assuming that currently juniper occupies the full extent of its potential habitat in the different forest planting districts (except for small area in Gissar-Darvaz for turkestan juniper), then possible climate change will change this. The semi-globular juniper and all the turkestan juniper in Gissar-Darvaz forest planting district may be lost. Unfavourable conditions for turkestan juniper may also occur in Chatkal-Ugam forest planting district. The most vulnerable to climatic changes may be tree-type turkestan juniper formations. Increase in climate change results in vertical shifting upwards from the present location, by up to 600 m by 2080. In addition, by 2030 and 2050, the area of favourable climatic factors coincides only marginally with Gissar-Darvaz forest planting district.

Thus unfavourable climatic conditions will develop in the current locations of tree-type Turkestan juniper, and at the same time favourable conditions will either develop elsewhere in new areas of Gissar-Darvaz district, or no such climatic factor combination will be found, as forecast according to scenario A2 for 2030 and 2050.

Existing tree-type turkestan juniper stands will be in conditions where they become unable to regenerate at the same place due to climatic factors. Unfavourably changing climate conditions may result in weakening, illness, and even in early loss of these stands. At the same time, the natural flexibility of this type of juniper, at least younger age classes, should be able to transform to tree-type form in the future, if, of course, the situation will not be a permanent change. Thus, the most vulnerable to climate change are mountain forest stands.

Figure 1. Chart of juniper formation layout in the climate grid in 2080 under scenario B2.



Key: 1 = zeravshan juniper; 2 = semi-globular juniper; 3 = tree-type form of turkestan juniper; 4 = crooked and bush-like stands of turkestan juniper.

Strategies for adaptation of forestry to climate change

- Strategy 1 – Legislative initiatives and institutional changes (Forest code, National forest programme).
- Strategy 2 – Improvement of the forestry management system (forest inventory, prospective plans for development of forest farms, including climate change taken into account; monitoring; database).
- Strategy 3 – Enhancement of effectiveness of forestry works (realistic work planning, grazing regulation, and mitigation of anthropogenic pressure).
- Strategy 4 – Improvement of professional skills in the forestry sector (manuals that take into account national forestry characteristics; professional development).
- Strategy 5 – Development of applied scientific research based on production needs (targeted scientific programmes, using knowledge gained for interrelation of science with production).

Status of assessment and research on climate change

Threats

In case of development of a situation on base scenario “as is”, the following threats for development of country’s forestry can be expected in the near future:

- lack of objective and comprehensive information on forest condition in the country will prevent planning of scientifically grounded forestry development;
- worsening of survival rate in regeneration and condition of existing forest stands due to traditional causes (lack of material and financial resources, application of truncated technologies,

uncontrolled grazing, illegal tree felling, fires, pests, diseases, etc.), as well as new and increasing negative climate change impact;

- change of forest planting district conditions in mountain territories under the influence of changing climate may lead to spatial shift in existing forest areas, i.e. there will be a shift upwards of growing boundaries for all tree and shrub species, with all the ensuing consequences, including biodiversity loss;
- reduction in the area of forest-covered lands, impoverishment of species composition, reduction of forest density and productivity of forests, worsening of age structure of forests, due both to traditional reasons and to global warming;
- tugai forests will become endangered, especially for euphratica poplar, as climate warming will inevitably result in increased water consumption for household and agricultural needs. Therefore further reduction of water yield and river sink regulation, which these unique forests depend on, can be expected; and
- field-protective forest stands may vanish, except for coppice linear plantings of mulberry and willow, which not may effectively perform a field-protective function.

Projects implemented in the field of forestry and climate change

Project I. "Training Programme on GHG emission reduction in Caspian Region" with the support of the Canadian International Development Agency (CIDA). The main purpose of the Programme is training of specialists from different economic sectors in elaboration and realization of projects on GHG emission reduction and CDM projects, preparation of project documentation according to the rules and standards of international donor agencies and investment funds; participation in carbon project tenders.

The CO₂ sequestration project provided experience in reduction of GHG emissions in the Caspian Sea basin (2003–2005), which included a sub-component of demonstrative CDM projects on forestry. Under the framework of this project it was planned to create forest plantations on the lands of one of the farmers of Djizzak region of Uzbekistan. Programme contact address: www.ctp-ghg.com

Project II. In 2007–2008, a project proposal on "Reconstruction and creation of forest plantations in Djambai and Zamin forest farms" was prepared as a CDM project.

The project's task was to test and demonstrate potential and benefits of joint management of forest farms in a CDM context. This project laid the foundation for replication of experience gained in forestry in Uzbekistan. The project had as its objectives:

- Creation of forest plantations on 206 ha of two forest farms by 2009 in accordance with CDM requirements. These include:
 - Reconstruction of young forest plantations with the purpose of increasing their density in accordance with CDM requirements on an area of 126.2 ha in the valley zone of Djambai forestry farm of Samarkand region;
 - Creation of new forest stands on an area of 20 ha in the valley zone of Djambai forestry farm; and
 - Creation of new forest stands on 60 ha in the mountain zone of Zamin forestry farm of Djizzak region in collaboration with local population (i.e. joint forestry management).
- A high level of CO₂ sequestration and mitigating climate change.
- Improving the methods of reforestation and managing the current forests.
- Creation of the necessary foundation for future initiatives in the CDM framework (departmental normative forest definition; improving existing models of tree growth calculation, and expanding them up to assessment models of CO₂ sequestration volume; compliance with the new National Forestry Development Plan; etc.).

A project proposal was approved by the National body on CDM and submitted to various carbon funds. One such fund (EcoSecurities, Ireland) expressed its interest in the project, but they were not ready to work with projects intended for afforestation/reforestation on areas of less than 2000 ha.

Project III. The project “Demonstration of conducting economic activity in arid conditions as an alternative for existing practices of economic activity and adaptation to changing climatic conditions on the example of farm “SBM Mukhammadamin” of Farish district of Djizzak region” was developed in 2008 under the GEF Small Grants Programme.

The proposed project plans to demonstrate an opportunity for sustainable land use under arid conditions in the foothill zone of Uzbekistan as an alternative to existing practices of economic activity and as adaptation to changing climatic conditions. The proposed approach enables simultaneous stabilization of the landscape and generation of sustainable income for the local population. In addition, the project assumes conducting on-site training on the example of practical lessons for farmers living in similar arid conditions. The project will be implemented using the example SBM Mukhammadamin farm, thus serving as an obvious case of how to re-orient people from animal husbandry to other systems of management, which restores vegetation, and holds back the processes of desertification and soil degradation.

Land in the foothill and upland zones in Uzbekistan are used mainly for dry sowing of grain crops and as pasture. The crops harvested in these territories mainly depend on annual precipitation, but harvests rarely exceed 8-10 t/ha and such harvests occur only once in 3 to 5 years. In other years, the harvest only compensates for expenses for seed, or there is no harvest at all. Pastures are degraded, low-productive lands due to overgrazing.

Climate change in Uzbekistan is progressing and may only worsen in the future: moisture availability may decline and consequently the probability of receiving reasonable crop harvests in non-irrigated lands (*boghara*) will decrease, as well as fodder biomass in pastures. In combination with increasing anthropogenic load, it will result in increasing the pressure on natural pastures, their further degradation and withdrawal of non-irrigated (dry) lands from economic turnover. In this context it becomes a necessity to find alternative methods of business, which could generate income for the people under conditions of current climatic change, and restore normal condition and functions of ecosystems of drying zones for further sustainable use.

This project proposes obtaining benefits for nature through creation of forest plantations possessing multifunctional reclamation features for the environment, and material benefits for local societies. The project aims to demonstrate that there are alternative methods of land use and income generation, unlike current unsustainable practices, even taking into account increasing aridity related to climate change. The project is in the stage of implementation.

Projects related to climate change in Uzbekistan without direct connection to forestry

- UNDP/UNOPS Regional Project "Capacity building for improvement National GHG inventories of countries (CIS/Europe region)" Project contact address: ghgii@sarkor.uz
- UNEP/Uzbekistan Project: "Implementation of Article 6 of UNFCCC on education, training and public awareness on climate change problem" Project contact address: ososkova@meteo.uz; info@climate.uz
- UNEP/Uzbekistan Project "Preparation of Second National Communication on Climate Change of the Republic of Uzbekistan under UNFCCC". Project contact address: ososkova@meteo.uz
- Uzbekistan/GEF/UNDP Project "National Capacity Self-Assessment on Global Ecological Conventions (NCSA)" Project contact address: raisa.taryanikova@ncsa.uzsci.net

- TACIS Project "Technical Assistance to Central Asian countries in implementation of their commitments on global climate change". Contact address of the project: zavlilya@mail.ru

One more project could be considered as having an indirect connection to an aspect of climate change, but possessing sequestration potential due to the great planned afforestation volumes. This is “*Achieving Ecosystem Stability on degraded land in Karakalpakstan and the Kyzylkum Desert*”, a project launched in February 2008 by UNDP-GEF and the government of the Republic of Uzbekistan. Prerequisites for beginning the activity of the project became occurrence of degradation and desertification of the lands on the territory of Karakalpakstan and the Kyzylkum desert. This project complies with the provisions of the National action programme of Uzbekistan on fighting desertification, especially through promoting physical anti-desertification measures such as improving the system of land use and afforestation, which are included in the programme. The project implementation period is 5 years, starting in February 2008. More information is available at www.undp.uz.

The main objective of the project is to test, evaluate and promote innovative solutions to the problems of land degradation at a pilot scale in Kyzyl Rovat and Kazakhdarya communities (a total area of 500 ha) and replicate best practices in order to achieve ecosystem stability on degraded land in Karakalpakstan and the Kyzylkum Desert. Upon completion of the works, the issue of spreading the positive experience to other regions, which require implementation of measures for fighting desertification and degradation of lands (a total area of 100 000 ha), will be considered. The objectives of the project are to be achieved through the following project outcomes:

- Plant species, having both strong ecological and economic benefits for succession in desert and semi-desert ecosystems identified and sustainable land management methods tested.
- Mobile sands stabilized and degraded land rehabilitated in partnership with local communities.
- Institutional and policy framework for integrated land use planning and management, strengthened.
- Monitoring and evaluation, learning and adaptive management, implemented.

Review of status and work by national research institutions on research for assessment of climate change effects on the forest sector

There is only one research institution dealing with forestry in Uzbekistan. This is the Republican Scientific-production Centre of Decorative Gardening and Forestry (former Scientific - Research Institute of Forestry). Until recently, the Centre had no research related to climate change impact on forestry. However employees of RSPC DG&F, being national consultants of GEF-supported projects on climate change or through private initiatives, were involved in projects directly connected with forestry.

References

- Botman, E.K. 1999. Assessment of climatic conditions and vulnerability of juniper formations under climate change in the territory of the Republic of Uzbekistan. pp. 54–64, in: Regional climatic scenarios, possible climate change impacts on agriculture and forest vegetation. Bulletin No. 1. SANIGMI, Tashkent.
- Botman, E.K. & Agafonova, O.A. 1999. Inventory of greenhouse gases in forestry of Uzbekistan. pp. 27–34, in: Mitigation measures on climate change in Uzbekistan. Bulletin No. 3. SANIGMI, Tashkent.
- Botman, E.K. 2008. Vulnerability of juniper formations to climate change on the territory of Uzbekistan. pp. 68–75, in: Bulletin. Climate change consequences in Uzbekistan, adaptation issues. Information on fulfilment of commitments to the UNFCCC by Uzbekistan. Edition No. 7. SANIGMI, Tashkent.

Proposed areas for cooperation

FAO's assistance would be appreciated in gaining access to world experience in:

- assessment of forest ecosystem vulnerability. A special method, which includes its strengths and weaknesses, was applied in order to assess vulnerability of Uzbekistan's forest ecosystems. Getting acquainted with other methodologies of vulnerability assessment will allow adoption of best experience and improve the quality of assessment of forest ecosystem vulnerability;
- practical measures of forestry's adaptation to climate change in similar conditions, taking into account climate change in prospective plans for forestry development. Learning the world experience of planning and implementation of complex of practical measures on adaptation to climate change in general, and in countries with similar edapho-climatic conditions in particular, will allow application of such experience in Uzbekistan taking into account local specific characteristics;
- preparing a successful CDM project in the field of forestry. At present, there are no CDM projects on forestry in the country, though there is great potential for such implementation. Detailed knowledge on preparation of project documentation, practical implementation of projects, distribution of benefits from its implementation, rights and obligations of participating parties would help in promoting such projects in the country;
- small catchment management. The fast reduction in glaciated areas, growing economic activity in the basin of the Syrdarya and Amudarya rivers, including in north Afghanistan, complete regulation of run-off of these rivers aggravates the water deficit in the region. Only 20% of Syrdarya and Amudarya runoff originates in the territory of Uzbekistan. Therefore creation of highly possible river runoffs on the country's territory becomes an essential issue. One of the basic means of solving this problem is scientifically based afforestation of mountain slopes in upper basin areas;
- preparation of courses of lectures for educational institutions and organizations on professional development in the field of climate change impact on the forest sector and methods of adaptation. Learning from the experience of countries where such training already exists would support preparation of equivalent courses for Uzbekistan.

Opportunities in related areas

- Reorganization of forest regulation and forest statistics. At present, due to the unsatisfactory condition of the forest regulation service, forest statistics are not trustworthy. Any decisions or estimates for the forestry sector must be based on reliable and real statistical data. This, in particular, also refers to statistical data required for undertaking GHG inventory in forestry.
- Implementation of small demonstration CDM project in forestry.
- Training in modelling of forest stand productivity in changing climatic conditions (e.g. the APSIM model). This model might help in assessment of the impact of climate change on growth and productivity of stands. Unfortunately, the forestry sector of Uzbekistan has no working experience in such modelling.
- Implementation of demonstration pilot project on catchment management.
- Implementation of demonstration pilot projects on pasture rotation in mountain and desert zones. In the territory of the State forest fund, including forest covered areas, overgrazing can be observed. This factor can be considered as a basic one due its impact on forest ecosystem degradation. Therefore creation of sustainable models for utilization of the forest fund in mountain and desert zones as pastures remains a priority task.
- Distribution of knowledge of climate change impact in forestry among specialists and the general population.