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assessment and adaptation plan for forestry sector
Project 00075206 "Third National Report to UNFCCC",
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In agreement with the ToR of the National consultant the first task for the National Consultant is to prepare the National circumstances section for the Third National Communication on climate change related to forestry sector.

**Third Draft Report**

## 1. Introduction

The UNDP and the Ministry of Environment and Physical Planning identified the need for National assessment of vulnerability of the forests in Republic of Macedonia to climate changes and develop a set of measures to establish their potential for adaptation. The main objective of the report is to strengthen the information base, analytical and institutional capacity of the key national institutions to integrate climate change priorities into country development strategies and relevant sector programs. The main aim is to provide the forest policy makers, forest managers and other interested parties (stakeholders) with information's that assist this sector to adapt to climate change. In particular, this report should provide the government, natural resource managers and business sector with:

- Information about the current knowledge and understanding about the possible biological and socioeconomic consequences that (or will) affect native and artificially planted forests in Republic of Macedonia;
- An asset of vulnerability of Macedonian forests from resource use and ecosystem services stand point;
- Show the measures (if any) that already have been taken in relation of managing the climate related risks in the sector;
- Major gaps in data collection and knowledge dissemination.

The report will also analyze the forestry sector, documents, studies, data collection methods, studies, and summarize the findings as national sector circumstances for the Third National Communication.

## 2. Climate change and forestry sector

Forests in Republic of Macedonia are expected to experience high level of impact from climate change, especially the boreal forests, where those impacts could be more dramatic. Climate change is already been documented throughout the Country as temperature increase, precipitation decrease, and seasonal changes. All those changes have huge impact on forests. While in other

sectors, the influence of these changes is becoming clearer; in the forestry sector we still have a lack of conceptual framework for determination of the vulnerability. This framework will assist forest managers to incorporate climate and climate changes into the forestry management plans.

### 2.1. Vulnerability of the forestry sector

Vulnerability of the forestry sector to climate change, can be defined as a relation between exposure, sensitivity and adaptive capacity of the sector (Smith, Pilifosova, 2001 –Tailored vulnerability approach for forest management), or

$$V = f(E, S, A),$$ where:

V- system vulnerability;

E- system exposure;

S- system sensitivity;

A- system adaptive capacity;

The relationship between E, S and A is not specified, because it will vary depending on the local circumstances. However, it is recognized that V is positive function of exposure and sensitivity, and negative function of system adaptive capacity (Ford, Smith, 2004).

This model can be modified in order to describe an approach to the sustainability of the human-ecological systems (Turner, 2003). This framework can be applied using local unique characteristics of the system at a specific location, and provides unifying framework to contrast and compare impacts of climate change throughout the State, and allows simultaneous consideration of several sources of exposure and sensitivity together with the adaptive capacity for particular environments.

According to this model, the major sources of exposure to climate change for forests in Macedonia are:

**Increasing of temperature:**

- changes: increasing working season, longer period of vegetation;

**Increasing of extreme events, floods, droughts:**

- changes: threat to infrastructure, life, inhabitants, socio-economic

**Increasing of forest fire activities:**

- changes: threat to infrastructure, reduction in wood supply, increased emission of GHG, decreased GHG absorption

**Increase of insect and diseases outbrakes:**

- changes: reduction of wood supply, decreased growth and yield

**Changes in forest productivity:**

- changes: wood supply and carbon sequestration

**Changes in species composition:**

- technology and market, recreational values

The major sources of climate change impacts on forestry sector can be split in several components:

- The nature of climate change – temperature, precipitation and wind patterns and their variability, which can affect a wide range of forest values;
- Uncertainty of forest management;
- Global changes such as nitrogen deposition, socioeconomic, market trends, land use changes;
- Impact on other forest values – NWFP, wild life habitats, biodiversity.

The impacts of climate changes in forestry sector can be either positive or negative. It is important to understand the opportunities that might exist in order to decrease their negative impacts on forests.

## 3. Climate change adaptation in forestry sector

Adaptive capacity of the forestry sector is mostly connected to forest management impacts, indicating that impacts are determined by exposure and sensitivity, as well as system's capacity to adapt. Adaptive capacity is defined by factors that determine the ability and possibility of forest managers to implement measures that will help reduce current and potential future impacts.

The main factors that influence forestry sector adaptation generally are divided in two major groups:

- Institutional flexibility and efficiency, policy, distribution and availability of financial resources, technological and human capacity;
- Knowledge and awareness of potential impacts, social networks, trust, isolation, infrastructure quality and climate risk perception.

It is important to stress that additional issues outside the climate change will occur at the same time, so the adaptive capacity of the forest sector should be considered from a broader point of view.

There are some aspects of sustainable forest management that can contribute to the adaptive capacity of the forest sector. Some of them are long term forest management plans that include climate change consideration, certification, etc.

## 4. Overview of in sector forestry

According to the Act on Forests (Official Gazette of RM, no. 64, from 22.05.2009), forests in Republic of Macedonia are defined as:

1) *Forest ecosystem that exist on forest land covered with forest tree and shrub species, bare land close to the forest, as well as other bare land and pastures inside the forest, forest nurseries, forest roads, seedling plantations, forest fire cleanings, wind protection belts with area larger than 2 a, as well as forests in protected areas. Forests also consist form young stands and forest plantations as well as areas that are currently uncovered as a result of human activities or natural hazards, where natural regeneration has begun.*

2) *Separate groups of trees on areas smaller than 2 a, border trees in agricultural land, plantations from fast growing tree species as well as river bank vegetation, alleys and parks in inhabited places are not considered as forest.*

This is a very wide definition of forest, and according to it, a large part of the state is considered to be a forest. It covers large areas in sub Mediterranean climate region that are covered with shrubs, that are not typical forest cite - tall, closely spaced trees.

### 4.1. Characteristics of sector forestry

Macedonia's forests cover around 1.095.000 ha of forest land, out of which as forests are recognized around 940.000 ha, or 1/3 of the total Country area (State statistical office, 2009). The total wood stock is estimated on around 75.000.000 $m^3$, and annual increment of around 1.830.000 $m^3$. The most dominant species are beech (Fagus moesiaca), and several oak species (Quercus spp.), that make up to 90% of all native forest types. Forests are mostly covered with deciduous tree species, and conifers cover around 11% of all forests. Around 550.000 ha are categorized as low quality coppice forests, and around 390.000 ha are categorized as high forests, out of which around 140.000 ha are plantations (artificially planted), mostly with coniferous tree species (Pinus nigra, Cupressus arizonica, …).

Regionally, the richest region is Southwest region with around 180.000 ha, and the poorest is Skopje region with around 125.000 ha. Distribution throughout the Country is uneven in terms of quantity and quality. High forests with good quality are located in the outskirts of the state border, far from the industrial and inhabited places and human influence. Low quality coppice forests are located in the central parts of the State, and their condition is partly result of the climate conditions, and partly from human activities.

Around 90% of the forests are in State ownership, and the rest is in private or other ownership (church). There are approximately more than 200.000 parcels of forests owned by around 65.000 households, averaging 0,6 ha.

In the terms of assignation, around 92% of total forest area has economical character, and around 8% are protective or protected forests. Annual allowed turnover, according to the approved management plans, is considered on around 1.200.000 $m^3$, and is around 2/3 of the annual increment, that is totally acceptable in terms of their sustainability. Most of this turnover comes from the State owned economic forests, and a very small part comes from protective and protected areas. Annual actual turnover is between 550.000 $m^3$ and 750.000 $m^3$, and mostly is firewood (80-85%), and is used from households. The logs are used mostly by domestic industry, and only a small part is exported.

State owned forest with economic assignment are managed by the special Public enterprise "Makedonski sumi", and the state owned protected forest are managed by the State pronounced PE National parks, or the local government offices.

### 4.2. Major forestry stakeholders

The Government of the Republic of Macedonia administers the forests and forestlands of state ownership through the following institutions:

- Ministry of Agriculture, Forestry and Water Economy;

The State Inspectorate of Forestry and Hunting functions as a body within the Ministry of Agriculture, Forestry and Water Economy, controls and supervises the enforcement of the Law on Forest, Law on Hunting and all other laws and law binding acts that are in the function of forestry and hunting. The Forestry Police as a sector within the Ministry of Agriculture, Forestry and Water Economy protects the forests in accordance to the Law on Forests.

- Public Enterprise "Macedonian Forests";

The public enterprise for forest managing, in a public ownership on the territory of the Republic of Macedonia “Makedonski sumi” s.r. – Skopje was founded on the basis of a Decision of the Government of RM No. 3028/1 on 15.12.1997 (Official gazette of RM No. 65/97), and started functioning on 01.07.1998 as a legal successor of the former enterprises for forest management. The General Director and Steering board are appointed by Government of R.M. The PEMF for its work refers directly to the Macedonian Government but its legal work is controlled from MAFWE. Taking into consideration the fact that the forests are natural good of public interest and the forest managing is activity of public interest, by Article 17 from the Forest Law the core activities are determined, which are: silviculture, protection and utilization of the forests, and with their execution, the enterprise should provide permanent preservation and constant enlargement of the forest value, as well as permanent enlargement of their increase and generally useful functions.

- Faculty of forestry in Skopje

The Faculty of forestry in Skopje is established in 1947 year. The main role of the Faculty is education but scientific work and applicable work are significant part of its activities, as well. One of the departments, in the frame of the Faculty, is Forest and wood protection department. The field of interest of this department, among other, is climate change and forest/forestry. This department is also in charge for ICP forest’s in Macedonia. There are other departments on the Faculty, which cover other parts of the forestry.

- Ministry of Environment and Physical Planning;

In the framework of the efforts aimed at integration into the modern trends of environmental protection in Europe and wider, and also as an important segment of the process of reforms, the Government of the Republic of Macedonia established the Ministry of Environment (Law on Amendment and Supplementing the Law on Public Administration Bodies", Official Gazette of RM" No.63/98).

Article 122-a of the Law on Amendment and Supplementing the Law on Public Administration Bodies defines the following competencies of the Ministry:

- state of the environment monitoring;

- proposing of measures and activities aimed at water resources, air and ozone layer

- protection against noise, radiation, conservation of biological diversity,

- geological diversity, national parks and protected areas;

- remedial of polluted parts of the environment;

- cooperation with scientific institutions for development of standards and regulations to regulate environment protection;

- development of self-financing system from independent sources, types and levels of

environmental charges and other payments;

- cooperation with civil associations, civil initiatives and other forms of civic activity;

inspection supervision in the field of its scope;

- other activities specified by law.

Within the framework of the Ministry of Environment and Physical Planning, functions State Inspectorate for protection of the environment that controls all legal and physical entities in the part of protection of the environment.

- National Parks:

There are tree national parks protected by law in Macedonia.

- The Pelister national park is the oldest, obtaining this status in 1948. The five-needle (Pelister) pine, the only such variety in the world, covers and area of about 12,500 hectares.

- The Mavrovo national park, covering an area of 11,750 hectares, was declares as such in 1949. In 1952 it was enlarged to 73,100 hectares. Some 27,000 hectares are forested. It is presumed that it includes more than 1,000 types of higher plant forms, about a 100 of which are extremely rare of endemic to the Balkans.

- The slopes of Mount Galichica, situated between Lake Ohrid and Lake Prespa and covering an area of 22,750 hectares, were declared a national park in 1958. Nineteen different forest communities have been discovered here. This indicated that the vegetation in this park is very rich, including several extremely rare types of flora.

- Public Enterprise "Jasen"

The Jasen forest reserve was proclaimed in 1958. It covers an area of 24,000 hectares and streches across the mountain massifs of Suva Gora, Suva Planina and Karadzhica. This reserve comes into the category of special natural reserves protecting many species of flora and fauna and other natural rarities.

- Private forest owners – An association of private owners that help private owners sustainably to use their forests. They have several regional offices throughout the country.

All these institutions have a good collaboration about all joint issues regarding forest and forestry. Some of the relations are in agreement with existing low obligations and some of them are as a result of long term collaboration. Reason more for this, is the fact that a great number of employed engineers, especially in the National parks and P.E. "Jasen", are forestry engineers.

### 4.3. Sector documents

The main law that regulates activities in the forestry sector in republic of Macedonia is the *Act on Forests* (Official Gazette of RM, no. 64, from 22.05.2009). It is relatively new law, that covers all aspects of forest activities (logging, protection, a forestation…), from plant point. - http://www.pravo.org.mk/documentDetail.php?id=4634

Also, concerning the wildlife management, there is a *Law of hunting* (Official Gazette of RM, no. 26/09) that covers management and protection of the wild life (game) in the state - http://www.pravo.org.mk/documentDetail.php?id=373 .

One of the strategic documents of the forestry sector is the *Strategy for sustainable development of forestry in the Republic of Macedonia* (adopted by the Government of the Republic of Macedonia in 2006). The strategy reflects all contemporary trends of the world forestry. In the same time, it gives methods for solution of the numerous problems in the Macedonian forestry in correlation with the demands of the sector, as well as in agreement with the principals of the sustainable development - http://www.fao.org/docs/up/easypol/580/4-2_strategy-macedonia_173en.pdf .

All management activities in the forestry are determined with the *Management plans*. There are about 270 management plans in the forestry sector in Macedonia (with ten years duration). In the management plans all management activities (silviculture, protection, utilization, afforestation etc.) are very precisely described and in agreement with the current legal legislative. The management plans are approved by the Ministry of agriculture, forestry and water economy.

The forest and forestry in Macedonia is treated in the *National and Local ecological action plans*, as well. In the Secund NEAP (2005) all aspects of forestry sector are taken into consideration and proper actions for monitoring and solving of environmental problems (including climate change) are proposed - http://www.moepp.gov.mk/default.asp?ItemID=5975722FD8B5534FBBA2DF27961DA8FA .

In the first two *National Communications to UNFCCC of Macedonia* the forest and forestry was reviewed in details, with vulnerability assessment and proposed measures for mitigation and adaptation, as well – http://unfccc.org.mk/content/Documents/Прв%20Национален%20Извештај%20на%20Р.%20Македонија%20кон%20Рамковната%20Конвенција%20за%20Климатски%20Промени%20на%20Обединетите%20Нации.pdf and http://www.undp.org.mk/content/Publications/SNC%20Climate%20change%20ENG.pdf.

Forest and forestry in Macedonia is also part of the *Spatial Plan of the Republic of Macedonia*, adopted by the Government of the Republic of Macedonia in 2004 year. The main chapters about forest and forestry in the Spatial Plan are : Forest and forest land, Goals and Plan determinants - http://www.moepp.gov.mk/WBStorage/Files/Prostoren%20plan%20na%20Republika%20Makedonija.pdf.

### 4.4. Data availability

Almost all relevant stakeholders in the State have significant data that is collected for their own use, or to be delivered to the State statistical office. They all need different data and the deepness of the analysis depend on their own approximation of the importance of the data. The Ministry of Agriculture, Forestry and water economy (MAFWE) collect and analyze one type of data, the

Ministry of Environment and physical planning has need for different data, PE "Makedonski sumi" (PEMF) has third type of data that concerned their work. All those institutions are legally obliged to send data to the state statistical office, where they collect and process different kind of data.

The most important data about the forest and forestry are coming from MAFWE and PEMF. Some of the tasks of the MAFWE are to monitor the forest and forestry and to carried out the policy of the State. In order to be able to do that MAFWE needs certain data. There are different sources of the data. One of them is PEMF and they have obligation to send certain data to the MAFWE. The second source is the Inspectorate for forestry, as a part in the MAFWE. The third source is the Faculty of forestry in Skopje In the frame of the Faculty there are two centers: Informative diagnostic and prognostic service and ICP forest's service. Some data MAFWE gets from the Hunting management plans, as well.

On the other site, PEMF also collects and provides data about the forest and forestry in Macedonia. There are two reasons for that. The first reason is the legal obligation to send data to MAFWE. The second reason is the need of proper data for evaluation of its own work and planning of the further management activities.

Generally there is enough data that can be obtained from all stakeholders, but the precision should be better. There is no good cooperation between all this subjects, in order to enhance the processing of available data. The list of necessary data that should be included in the processing statistical data at the State statistical office, certain methodology for data collecting and the subject that is obliged to collect, should be prepared.

## 5. Review of recent research, projects and other activities

In the last five years (2007-2012) there were some activities in terms of forest, forestry and climate change.

1. The connection of climate change and increment of forest fires is recognised not only in Macedonia but also globally. As a consequence of the number of fires and burned area in the last fifteen years FAO/TCP project was carried out (2008-2012) under leadership of the Ministry for agriculture, forestry and water economy. The title of the project is: Strengthening National Forest Fire Preparedness-The Former Yugoslav Republic of Macedonia. Main activities of the project were: public awareness campaign (with proper material), procurement of hand tools and personal protective equipment, training for trainers and preparation of the National Forest Fire Management Plan.
2. In the year 2006 the net of ICP forest's plots (Level I) was reestablished in Macedonia. It is an activity of the MAFWE but the National center responsible for ICP Forest's is situated in the Faculty of forestry in Skopje – Department for forest and wood protection. All plots are assessed each year (from 2006 till now) in agreement with the official ICP Forest's methodology. Among others, the influence of the climate change of the forest is assessed as well.

3. As a result of the trilateral collaboration between Macedonia, Greece and Albania the project "Integrated Ecosystem Management in the Prespa Lakes Basin of Albania, Macedonia and Greece" was realised. The project was coordinated and financed by UNDP. Many aspects of the ecosystem management and protection were treated in the project and one of them was Protection of Greek juniper forest against fires. A monitoring system for forest fires in the Greek juniper forest, equipment, training and public awareness campaign are planned as main activities in this part of the project.

4. One of the measures for climate change adaptation and mitigation is the afforestation. Apart of the afforestation in accordance with the management plans, PE "Macedonian forest" has an active participation in the "Tree day" action in Macedonia. In the frame of this action around 9.000.000 seedlings are planted through Macedonia each year in the last five years.

5. One of the measures for decreasing of the number and consequences of forest fires is creating of early warning system. It is a measure for adaptation and mitigation of the impact of climate change of forest and forestry sector. Taking this and already recognized problem with forest fires into consideration, there is on-going joint JICA/UNDP/CMC project: *"Development of Integrated System for Prevention and Early Warning of Forest Fires"*.

## 6. Methodology, Tools and Indicators for climate change impact assessment of the forestry sector

Forests and forest sectors are influenced with a great variety of factors that are product of climate change. This specter of factors is not influencing this sector separately, but with great interaction and can be noticed in the various forest management neighborhood as physical environment, forest growth, utilization of forest resources, market changes, etc. Those different areas of influence need different approach and models of estimation the climate change impact on all those areas, as well as integrating those different models from different disciplines.

There are different ways of integrating cross-disciplinary impact assessments, such as linking, coupling and integrated modeling. The review of the existing experiences emphasizes the problem of complexity and the need to simplify disciplinary approaches. There have been a lot of discussion about the scaling issues that are important for impact assessment modeling in forestry sector, including the consequences of heterogeneity in site conditions (important variable for forest growth and renewal), influence of the extreme events on ecosystem and economic sector, as well as the difference between temporal and spatial scales over sources of uncertainty in forest impact assessment modeling.

### 6.1. Factors influencing climate change impact assessment modeling in forestry

Modeling the impact assessment of climate change in forestry sector is very complicated because it is influenced by a number of factors. Most of them are very different from other sectors, and some of them are similar to other sectors. Some of those factors are:

- ***Heterogeneity of forest site conditions*** diversifies the possible ecological and economic response to climate change. The diversity of sites influences the impact of climate change, and mostly increases the requirements for participation from different disciplines such as climate, soil, vegetation, conservation, forest management, wood production and resource economics.
- ***The carbon cycle*** connects forestry directly with atmosphere. The enormous size of atmospheric flux caused by land-use change management show that forests are playing special role in climate change policy.
- ***Differences in temporal and spatial scales*** where forest related processes operate should be reconciled within the process of impact assessment, because it is very likely to experience higher altitude ecosystems to increase the productivity. Those positive responses is expected to generate benefit in long-term, while the short-term effects will be increasing of area of disturbance and dieback, as well as disruption of regional markets.
- ***Uncertainty related to extreme events and natural disturbances*** prevent the estimation of climate change impact. Dynamics of disturbances play a significant role in forest ecology and management. The impact of magnitude and extent of those disturbance events brings uncertainty related to the climate change impact on those characteristics. If there are no changes in disturbance regimes, the long life of trees as well as the low migration potential of forest ecosystem will result with slow adaptation and environmental changes. Disturbances (fire, drought, winds) could potentially open up large areas of forests for regeneration under altered climate that will require different species.
- ***Diversity of stakeholders*** results in a divers objects for forest management, including economic, recreation, preservation and conservation. The multitude of ecosystem services provided by forests leads to enormous interest from public and pressure from environmental NGO's in forest resources management.

Subsequently, the assessment of climate change impacts on forestry sector requires specific methodology that aggregate across spatial and temporal scales, as well as the different disciplines associated with forests and forestry.

**6.2. Integrated methodology for cross-disciplinary impact assessment**

Integrated modeling represents the third level of edification, where different sub-models are integrated into a common model framework. This type of linking is still far from forestry sector, although there are several models that include economic sectors without forestry. The key factor for successful integration of different disciplines in impact assessment is balance (fig. 1.).

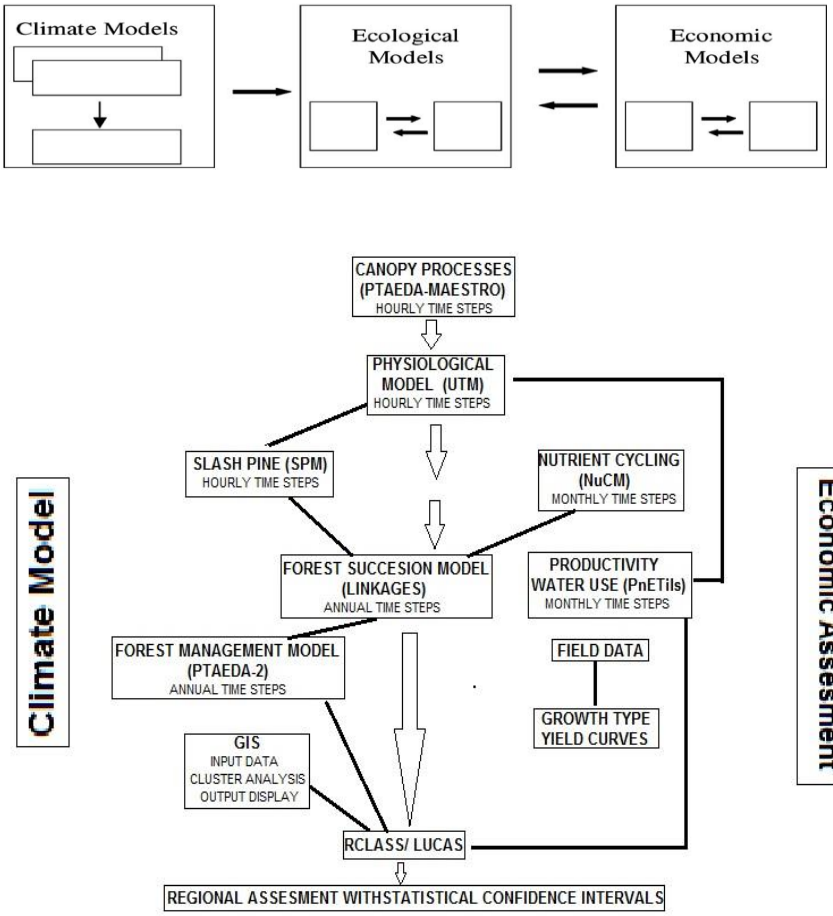



Fig.1: Schematic approach

Balance can be achieved in different ways, but it has to be done with the same treatment of all disciplines with similar degree of precision. This is very difficult to achieve in practice because different disciplines have different standards and different accuracy in the process of representation. Strict enforcement of such standards can produce imbalance, and omitting this standards can produce wrong results from each discipline.

The complexity of impact assessment often needs to be simplified due to the difficulty to incorporate every important process across all disciplines. Therefore, there should be carefully chosen processes that should be tested with sensitivity analyses, and which processes should address through more complex model representation. Generally, the more disciplines involved, the more limited number of scenarios that can be analyzed. German national climate change impact assessment (Linder and Cramer, 2002), analyzed forest sector responses under (i) scenarios of climate changes, coupled with (ii) alternative managing strategies, (iii) economic scenarios affecting timber prizes and (iv) scenarios determining the area of forests with protection status and management constrains.

Most models for forest sector are developed with single discipline and interdisciplinary work on common integrated approach is exception. Most recent models for impact assessment on forestry sector combine steady ecological predictions with dynamic economic models, and they include transient climate change scenarios the consequent transient forest productivity changes.

They did not include forest type changes or the climate change impact on international forests and forest sector trade.

Models should also include the other forest services (conservation of biodiversity, clean water supply, recreation …). There are limited understandings of how those qualitative measures are related to human or ecological well being.

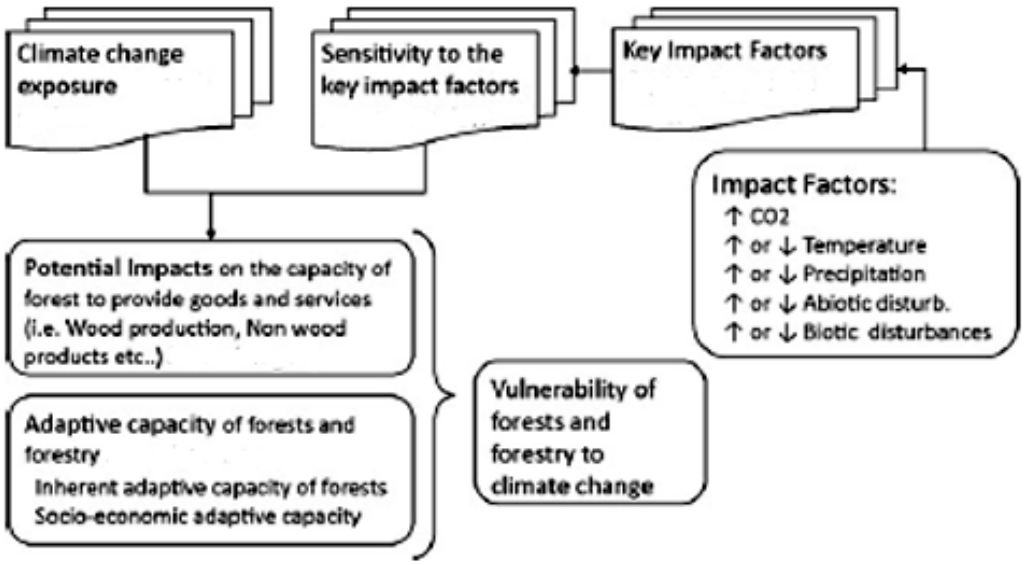



Fig.2: Scheme of the approach followed to assess the climate change impacts and vulnerability in European forests

The concepts of impact, vulnerability, risk and adaptation are not clearly defined and interpretation of terms by scientific groups or policy makers can be quite different, which may lead to fuzzy or even false expectations and responses. The methodological approach shown in Fig. 2 will be used for climate change impact assessment of the forestry sector in Macedonia. It is the same approach used for assessment of the climate change impacts and vulnerability on European forests and forestry. The following terms will be used for this purpose:

- Impact factors are climatic, physical, and biological variables that are influenced by climate change and cause the impacts in the system.
- Exposure specifies the projected change of climate that is affecting the system.
- Sensitivity describes the degree to which a system is affected, either adversely or beneficially. The effects of climate change may be direct (e.g. changes in forest growth in response to a change in temperature or precipitation) or indirect (e.g. damages caused by an increase in the frequency of fires or a new biotic pest species).
- Impacts are the consequences of climate change that are likely to affect forest goods and services and forestry activities, as a function of exposure and sensitivity to changes.
- Adaptive capacity describes the ability of a system to adapt to changes in climate.

- Inherent adaptive capacity summarizes the evolutionary mechanisms and processes that permit tree species to adjust to new environmental conditions.
- Socio-economic adaptive capacity is the ability of human sectors, like forestry, to implement planned adaptation measures.
- Vulnerability can be defined as the degree to which a system is susceptible to be affected by adverse effects of climate change. The vulnerability of a given system is a function of the climate variation to which this system is exposed (exposure), its sensitivity (together resulting in impacts on goods and services), and its adaptive capacity.
- Risk is the potential adverse outcome of a particular impact.
- Opportunity is the potential beneficial outcome of a particular impact.

In order to meet the goals of the Third National Report to UNFCCC for the forestry sector, the following direct and indirect impact factors will be treated for the forests and forestry in Macedonia:

- changes in temperature
- changes in precipitation, flooding, drought duration and frequency
- abiotic disturbances (changes in fire occurrence, changes in wind storm frequency and intensity)
- biotic disturbances (frequency and consequences of pest and disease outbreaks)
- uncertainty of forest management

Nevertheless, although we have described the methodology for climate change impact assessment of the forestry sector there are still no official and harmonized tools and indicators for that purpose. Usually, the assessment of the climate change impact in different countries and regions in the World and Europe is based on the local knowledge's, experiences, researches etc. It is result of different types of forests, climates, social and economic circumstances. It means we will have the same approach and methodology like all countries members of the European Union and will use international and national experiences and knowledge's instead specific tools and indicators (which does not exists).

## *7. Vulnerability assessment of climate change impact on forest and forestry sector*

According to the ToR for the national consultant for preparation of climate change vulnerability assessment and adaptation plan for the forestry sector, one of the tasks is:

"• Prepare vulnerability assessment of climate change impact on forestry sector as part of the Third National Communication on climate change, assessing the potential impacts of climate change on the forests in the country, covering the following aspects to the extent possible i.e:

- focus on biological condition of the forest (forest types, their health condition, belt moving, forest fires, insects and pests etc.), keeping in mind how climatic factors will potentially threaten or impact these
- analyze climate change impact on forest management and identify most vulnerable segments (change of work and season regime)

- analyze forest fires in terms of economic loses, damages, expenses for fire-fighting and rehabilitation of the burned sites/forests)
- assess/evaluate the impact of the forest fires that happened in the last 10 (5 years) in terms of the reduced potential for carbon sequestration
- evaluate the potential of the forests in terms of carbon sequestration
- assess the adaptation potentials and GHG emission reductions of the "Day of the Tree" initiative in the past six years."

The impacts of the climate change on forest are various throughout the world, depending on the forest types. Impacts include increased growth, increased frequency and intensity of fires, pests and diseases, as well as potential increase in the severity of extreme weather events (droughts, rainstorms and wind). Human activities, including forest conservation, protection and management practices, interact with climate change and can speed up, or slow down some of the impacts. In the following chapters, the major impacts of climate change on forest will be reviewed.

**- Climate change impact on forest health condition**

It is very likely that area covered with forests in Macedonia will change under influence of climate changes, due to the change of temperature and precipitation regime. Almost everywhere, in all forest types, there will be change in species composition, but that will be more visible in the longer period of time. By the 2025, according to the climate change scenario, those climate changes will not be so dramatic that forest cannot adapt to them. Increasing temperature for 1,1$^{o}$C, and decreased and changed precipitation regime, will affect the annual growth and yield of the forests, but that will not be as dramatic, due to the different needs of different tree species.

In the last 10 years territorial expansions of some trees was noticed in Macedonia but it is very difficult to make conclusion that is as a consequence of climate change. For example, Pinus peuce in the National park "Pelister" has occupied terrains with 2400 – 2500 m a.s.l. According to the literature the highest point for its spreading is 2 200 m a.s.l. On the other hand, in the same park P. Peuce has occupied terrains lower than its spreading in the past, as well. So, there is no logic in the explanation that main reason for that is the climate change. Much more it will be explained with the invasion of the P. Peuce of the abandoned agricultural lands (lower parts of the park) and pastures (highest parts of the park).

On the other hand, the problems and impact could be noticeable at the artificially planted forests, mostly from coniferous species, that are not suitable for the environmental conditions in planting areas (especially in the submediterannean climate), and we can expect some loses of area planted with those species.

In order to evaluate the health condition of the forest in Macedonia we will use the results of the ICP forest's assessment for Macedonia. This is an assessment done using the official methodology for all Europe, USA and Canada for assessment of tree (forest) condition in relation with air pollution and climate change. According to this methodology 29 plots for assessment are established in Macedonia (Picture 1). There are many indicators for the health condition of the forest but we will show just two of them: water availability for the trees (soil moisture) and crown transparency. They are one of the indicators of the health condition of the trees and climate

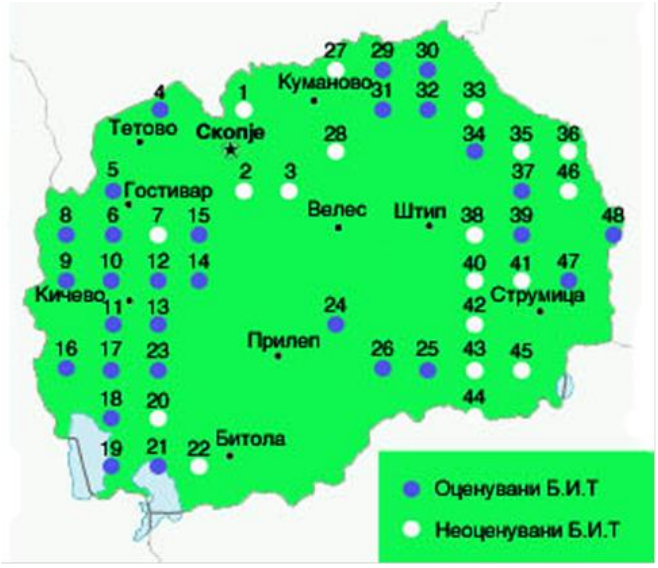
change. It will be done for the years: 2008, 2009 and 2011. In order to have more clear picture for the health condition of the forest in Macedonia, just for the continuity, some of the results from the previous reports (period 1991-2006 year) will be reviewed as well. It means that we can see the health condition of our forest in the last 20 years.

According to the results showed in the Tables 1, 2 and 3 we can conclude that the health condition of the forest in the period between last National Communication on climate change in this one (2006-2013 year) more or less is the same. There are no significant changes in terms of the percentage of the crown transparency. Around 50% of the assessed trees don't have signs of crown transparence but around 45% of the trees are in the 1 and 2 class of the scale of loss of needles/leaves (>10<60%). It means that these trees will be most vulnerable on the climate change in the next period. It will depend of: severity of the climate change, tree type, type of forest management, pests and diseases infestation etc.

On the other side, results for the water availability for the trees (soil moisture) reviewed in the Fig.: 3, 4 and 5 shows that on the around 65% of the plots the water availability for the trees is insufficient (in the period of the assessment – September). If we take into consideration the fact that it is Sptemberand the soil types it is not very unusual but still it should be taken into consideration for the analyzes of the influence of climate change for the future.

In agreement with the scenario for the climate change for Macedonia (air temperature and precipitations) we should not expect some significant impact of climate change of the health condition of the forest. But, there are no showed or predicted climate excesses (short and severe dryness, extreme min. or max. air temperature etc.) in the scenario, as a causer of "stress" of the trees. The stress of the trees very often is reason for physiological weakness of the trees and that is precondition for health disturbances of the trees. It means, taking all previous into consideration, if there are some climate excesses we can expect negative change of the health condition of the forest even in the period till 2025. It will be as a result of the climate change as well.

Picture 1: The net of the ICP forest's plots in Macedonia



The crown transparency is divided in five classes, which are:

| Class | Scale of loss of needles/leaves | Percentage of loss of needles/leaves |
|---|---|---|
| 0 | no loss of n/l | from 0 – 10 % |
| 1 | small loss of n/l | >10 < 25 % |
| 2 | moderate loss of n/l | >25 < 60 % |
| 3 | high loss of n/l | > 60 % |
| 4 | dead tree | 100 % |

Crown transparency

Table 1

| Year of assessment | Scale of loss of needles/leaves | | Class | Percentage of assessed trees |
|---|---|---|---|---|
| 2008 | no loss of n/l | from 0 – 10 % | 0 | **42,1%** |
| | small loss of n/l | >10 < 25 % | 1 | **34,2%** |
| | moderate loss of n/l | >25 < 60 % | 2 | **19,9%** |
| | high loss of n/l | > 60 % | 3 | **3,1%** |
| | dead tree | 100 % | 4 | **0,7%** |
| | | | | |
| 2009 | no loss of n/l | from 0 – 10 % | 0 | **53,7%** |
| | small loss of n/l | >10 < 25 % | 1 | **25,8%** |
| | moderate loss of n/l | >25 < 60 % | 2 | **17,2%** |
| | high loss of n/l | > 60 % | 3 | **2,7%** |
| | dead tree | 100 % | 4 | **0,6%** |
| | | | | |
| 2011 | no loss of n/l | from 0 – 10 % | 0 | **50,1%** |
| | small loss of n/l | >10 < 25 % | 1 | **27,3%** |
| | moderate loss of n/l | >25 < 60 % | 2 | **19,1%** |
| | high loss of n/l | > 60 % | 3 | **2,8%** |
| | dead tree | 100 % | 4 | **0,7%** |

Crown transparency in sample plots under oak forests

Table 2

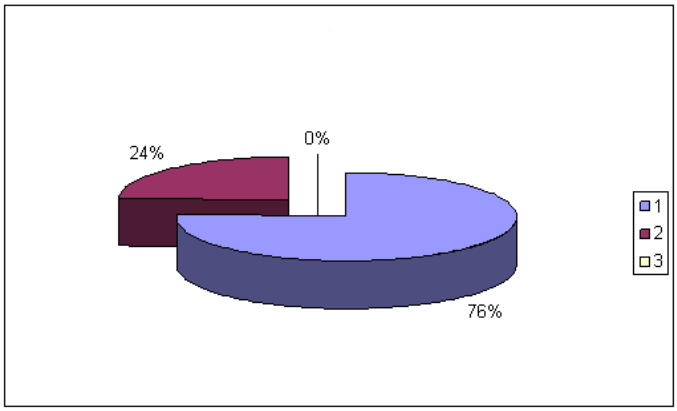
| CROWN TRANSPARENCY - % | | | | | |
|---|---|---|---|---|---|
| | 1991 year | | | | |
| | Classes of crown transparence | | | | |
| Sample plots | 0 | 1 | 2 | 3 | 4 |
| Ograzden | 82,7 | 11,9 | 4,8 | 0,6 | 0 |
| Manastirska suma | 73,9 | 18,5 | 3,1 | 1,4 | 2,8 |
| Klinski Livadi | 72,4 | 21,6 | 4,9 | 1,1 | 0 |
| **Average:** | **76,4** | **17,4** | **4,3** | **1,0** | **0,9** |
| | 1993 year | | | | |
| Ograzden | 96,1 | 2,5 | 1,3 | 0 | 0 |
| Manastirska suma | 93,3 | 1,7 | 0 | 0 | 4,6 |
| Klinski Livadi | 52,4 | 35,7 | 9,2 | 1,1 | 1,6 |
| **Average:** | **80,6** | **13,4** | **3,5** | **0,4** | **2,1** |
| | 1994 year | | | | |
| Ograzden | 94,0 | 3,7 | 2,3 | 0 | 0 |
| Manastirska suma | 27,1 | 50,9 | 12,2 | 0,7 | 8,4 |
| Klinski Livadi | 51,2 | 35,8 | 6,8 | 1,3 | 4,9 |
| **Average:** | **57,5** | **30,2** | **7,2** | **0,6** | **4,5** |
| | 1996 year | | | | |
| Ograzden | 74,3 | 9,5 | 12,5 | 2,2 | 1,5 |
| Manastirska suma | 27,1 | 48,2 | 14,3 | 1,7 | 8,7 |
| Klinski Livadi | 49,2 | 35,5 | 8,2 | 1,6 | 5,5 |
| **Average:** | **50,2** | **31,1** | **11,7** | **1,8** | **5,2** |
| | 1999 year | | | | |
| Ograzden | 71,1 | 10,9 | 13,3 | 2,9 | 1,8 |
| Manastirska suma | 27,0 | 46,6 | 15,4 | 2,0 | 9,0 |
| Klinski Livadi | 49,0 | 34,9 | 8,5 | 2,2 | 5,4 |
| **Average:** | **49,0** | **30,8** | **12,4** | **2,4** | **5,4** |
| | 2003 year | | | | |
| Ograzden | 78,8 | 10,1 | 8,1 | 1,2 | 1,8 |
| Manastirska suma | 32,5 | 48,2 | 9,3 | 1,0 | 9,0 |
| Klinski Livadi | 58,9 | 30,6 | 3,8 | 1,3 | 5,4 |
| **Average:** | **56,7** | **29,6** | **7,1** | **1,2** | **5,4** |
| | 2006 year | | | | |
| Ograzden | 79,0 | 17,5 | 1,0 | 0,7 | 1,8 |
| Manastirska suma | 45,1 | 40,3 | 4,6 | 1,0 | 9,0 |
| Klinski Livadi | 65,8 | 27,2 | 1,1 | 0,5 | 5,4 |
| **Average:** | **63,3** | **28,4** | **2,2** | **0,7** | **5,4** |

Crown transparency in sample plots of fir forests

Table 3

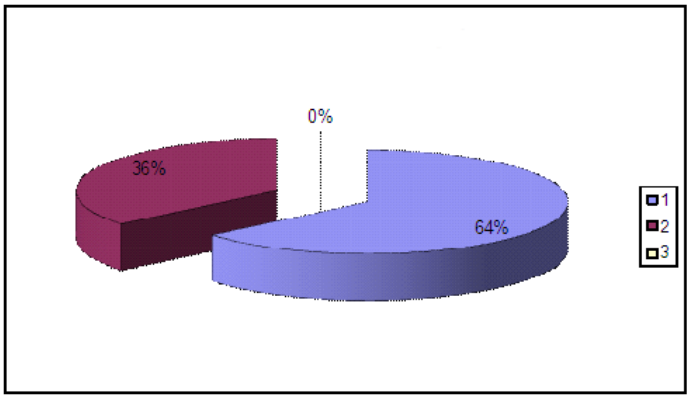
| CROWN TRANSPARENCE - % | | | | | |
|---|---|---|---|---|---|
| 1991 year | | | | | |
| Classes of crown transparence | | | | | |
| Sample plots | 0 | 1 | 2 | 3 | 4 |
| Lesnicka Reka | 53,8 | 26,6 | 18,9 | 0,7 | 0 |
| Turska cesma | 42,4 | 21,9 | 18,9 | 3,9 | 12,9 |
| Brajcino | 60,6 | 31,3 | 8,1 | 0 | 0 |
| Gorna Radika | 90,6 | 9,4 | 0 | 0 | 0 |
| **Average:** | **61,8** | **22,3** | **11,6** | **1,1** | **3,2** |
| | 1993 year | | | | |
| Lesnicka Reka | 73,4 | 18,2 | 8,4 | 0 | 0 |
| Turska cesma | 46,2 | 18,2 | 18,2 | 3,8 | 13,6 |
| Brajcino | 79,8 | 16,2 | 3,0 | 0 | 0 |
| Gorna Radika | 79,1 | 20,9 | 0 | 0 | 0 |
| **Average:** | **69,6** | **18,5** | **7,5** | **1,0** | **3,4** |
| | 1994 year | | | | |
| Lesnicka Reka | 94,7 | 5,3 | 0 | 0 | 0 |
| Turska cesma | 67,4 | 14,8 | 3,7 | 1,5 | 12,6 |
| Brajcino | 95,0 | 2,0 | 1,0 | 0 | 2,0 |
| Gorna Radika | 96,2 | 3,8 | 0 | 0 | 0 |
| **Average:** | **88,3** | **6,5** | **1,2** | **0,4** | **3,6** |
| | 1996 year | | | | |
| Lesnicka Reka | 94,0 | 5,3 | 0,7 | 0 | 0 |
| Turska cesma | 67,4 | 14,2 | 4,4 | 0,7 | 13,3 |
| Brajcino | 92,0 | 4,0 | 2,0 | 0 | 2,0 |
| Gorna Radika | 95,4 | 4,6 | 0 | 0 | 0 |
| **Average:** | **87,2** | **7,0** | **1,8** | **0,2** | **3,8** |
| | 1999 year | | | | |
| Lesnicka Reka | 93,0 | 5,0 | 0,5 | 1,0 | 0,5 |
| Turska cesma | 67,0 | 13,8 | 4,2 | 1,7 | 13,3 |
| Brajcino | 91,0 | 2,3 | 1,3 | 0 | 5,4 |
| Gorna Radika | 95,0 | 4,2 | 0,2 | 0,6 | 0 |
| **Average:** | **86,5** | **6,3** | **1,6** | **0,8** | **4,8** |
| | 2003 year | | | | |
| Lesnicka Reka | 94,0 | 4,5 | 0,5 | 0,5 | 0,5 |
| Turska cesma | 70,0 | 12,5 | 3,3 | 0,9 | 13,3 |
| Brajcino | 91,0 | 2,5 | 1,1 | 0 | 5,4 |
| Gorna Radika | 95,5 | 4,0 | 0,2 | 0,3 | 0 |
| **Average:** | **87,6** | **5,9** | **1,3** | **0,4** | **4,8** |
| | 2006 year | | | | |
| Lesnicka Reka | 95,1 | 3,6 | 0,5 | 0,3 | 0,5 |
| Turska cesma | 76,3 | 7,7 | 2,0 | 0,7 | 13,3 |
| Brajcino | 92,0 | 2,4 | 0,2 | 0 | 5,4 |
| Gorna Radika | 95,6 | 4,0 | 0,3 | 0,1 | 0 |
| **Average:** | **89,8** | **4,4** | **0,7** | **0,3** | **4,8** |

Fig. 3: Water availability for the trees – 2008 year



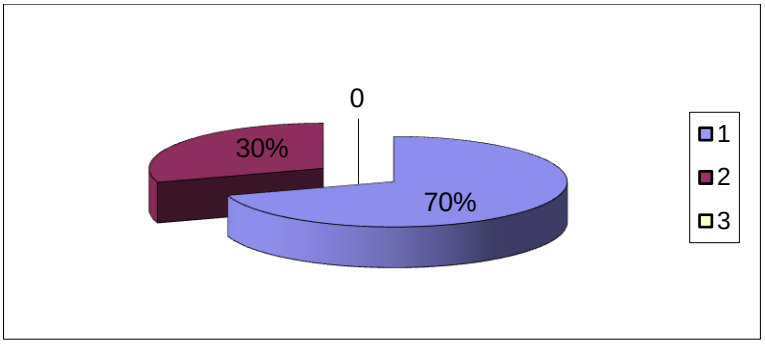

1-Insufficient 2-Sufficient 3-Excessive

Fig. 4: Water availability for the trees – 2009 year




1-Insufficient 2-Sufficient 3-Excessive

Fig. 5: Water availability for the trees – 2011 year




1-Insufficient 2-Sufficient 3-Excessive

Forest fires

Table 4

| Year | Number of fires | Burned area (ha) | Burned timber mass ($m^3$) | Suppression fees (euro) | Total fees (euro) |
|---|---|---|---|---|---|
| **1999** | 69 | 2 414,80 | 1 950,0 | 32 512,00 | 372 .921 |
| **2000** | 476 | 46 235,73 | 711 782,00 | 976 142,00 | 15. 642. 775 |
| **2001** | 161 | 6 263,30 | 88 260,00 | 66 810,81 | 9. 851. 849 |
| **2002** | 65 | 1 186,30 | 24 661,28 | 15 193,10 | 298. 902 |
| **2003** | 144 | 1 068,88 | 10 987,00 | 44 607,87 | 251. 527 |
| **2004** | 94 | 892,05 | 4 322,30 | 23 214,55 | 1. 469. 090 |
| **2005** | 182 | 1 368,00 | 1 063,00 | 42 018, 11 | 411 .181 |
| **2006** | 138 | 2 085,95 | 12 978,00 | 45 311,20 | 2. 437. 914 |
| **2007** | 652 | 35 248,6 | 617 678,67 | 386 852,46 | 21. 494. 700 |
| **2008** | 323 | 10 143,1 | 53 055,6 | 96 278,69 | 4. 612. 377 |
| **2009** | 38 | 197,00 | 756,50 | 313,627.00 | 5.812.889 |
| **2010** | 64 | 1,112.50 | 5 000,00 | 985.455.00 | 90.000 |
| **2011** | 390 | 20 856,8 | 65 042,8 | 400 153,00 | 1 .719. 105 |
| **2012** | 385 | 19964,9 | 155 126,00 | 410 323,00 | 4.248.828 |
| **Total** | **2 791** | **128 181,1** | **1 687 620.35** | **3 438 345.79** | **66. 994. 953** |
| *Average* | *199,4* | *9 155,8* | *120 544.3* | *245 596,12* | *4. 785. 353* |

One of the widely recognized consequences of climate change is forest fire. In the last 20 years Republic of Macedonia has a significant problem with forest fires. Around 2 800 forest fires are recorded in the period 1999-2012 year which has burned almost 130 000 ha forest and forest land. The total damage (direct and indirect) is estimated on around 67 000 000 euro.

Fig. 6: Number of forest fires (1999 – 2012 year)

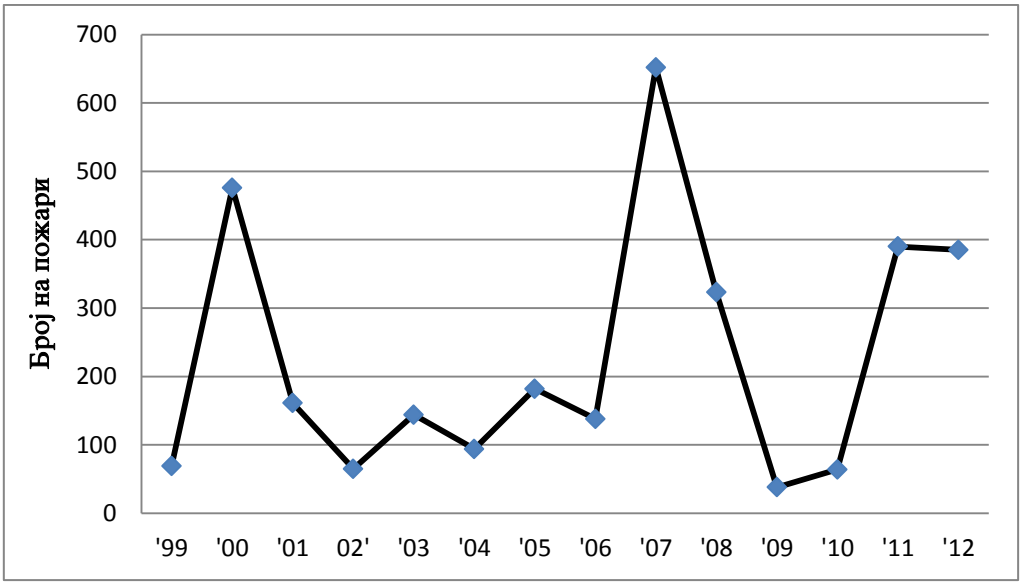
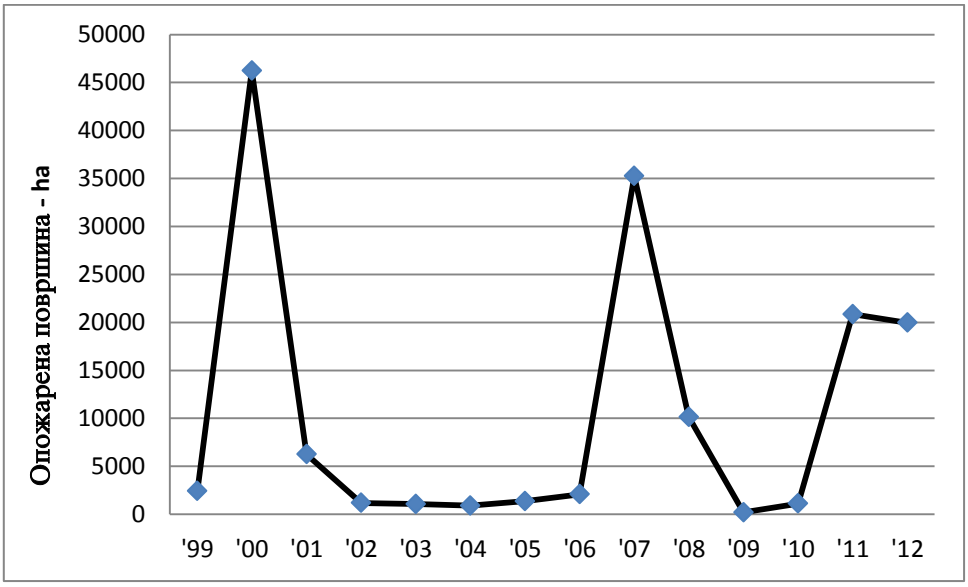



Fig. 7: Burned area (ha) from forest fires in the period 1999 - 2012 year




**-Forest ecosystem services**

*Productivity*

The impact of climate change on productivity varies according to the geographical area, tree species, stand composition, tree age, soils, $CO_2$ effects, nitrogen fertilization and interaction

between all this factors. Some of those changes could be temporal, and some permanent. In the period between second and third National communication there is no significant changes in the forest productivity. In general, until 2025, we could expect increased productivity of forests, due to the rising temperature and $CO_2$ fertilization. But, the water deficit could decrease the productivity that may not result in the forest dieback. Natural disturbances are also a factor that can decrease productivity through the damage they cause to the standing trees.

*Carbon storage and sequestration*

Since carbon sinks depends on forest productivity, all factors that affect productivity will also affect carbon sequestration. As we mentioned, only forest fires had significant negative influence on the decrement of carbon storage and sequestration capacity of our forest in the previous period. By 2025, Macedonian forest, due to the predicted increasing productivity, will be able to increase their carbon sink capacity, if there are no enormous changes in number and intensity of forest fires (as it was in 2000). What is the potential of Macedonian forests for carbon stock?

The total ecosystem C stock is large and dynamic equilibrium with its environment. Because of the large areas involved at regional and local scale, forests and forest land are one of the key players in global C cycle. Land use change can cause perturbation of the ecosystem and can influence the carbon stock and fluxes. In general, conversion of forests and forest land to agricultural ecosystems can reduce the soil organic carbon (SOC) concentration and stock between 20-50%. (Schlesinger,1985). General capacity for carbon stock of forest ecosystem is presented in figure 8.

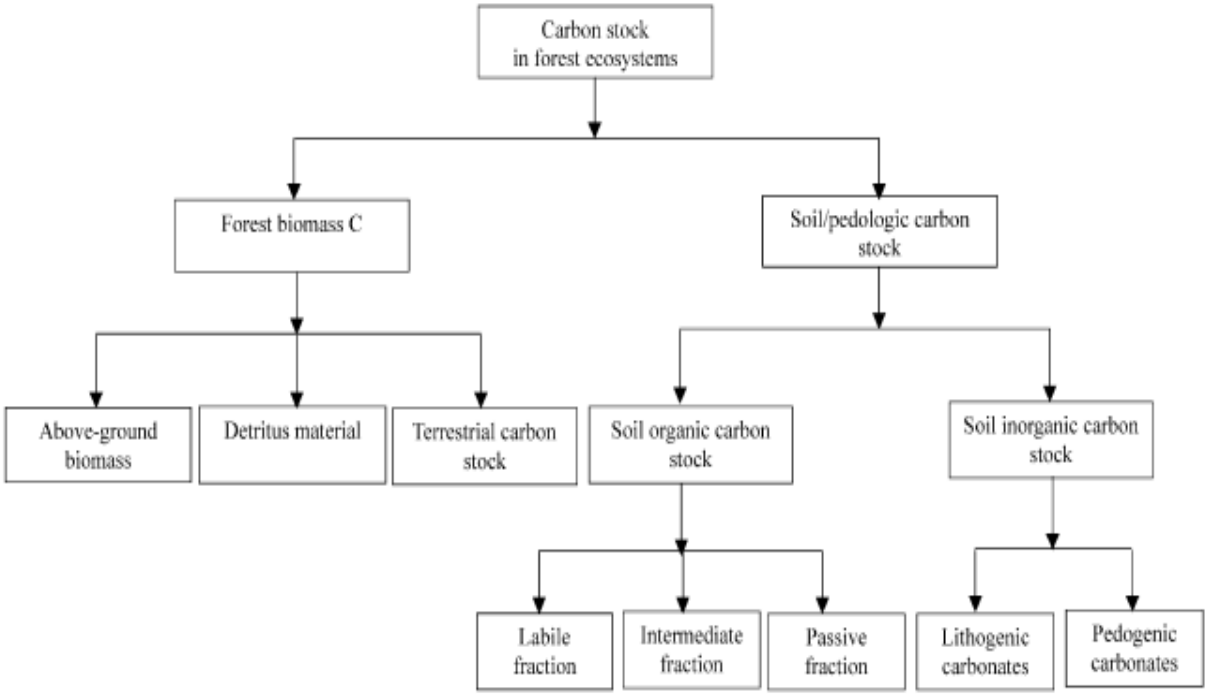



Fig. 8 Components of the terrestrial carbon stock

So, according to the figure, estimation of the forest carbon sequestration is a very complex and long- term work that need to be done in Republic of Macedonia. There are numerous of factors that have to be taken into consideration. The primary data should come from forest inventory data

(forest stock, forest growth, forest species, net annual increment by age classes, area, thinning, final cuts,……), as well as soil carbon, litter and forest products. (Figure 9, T. Karjalainen, 2002).

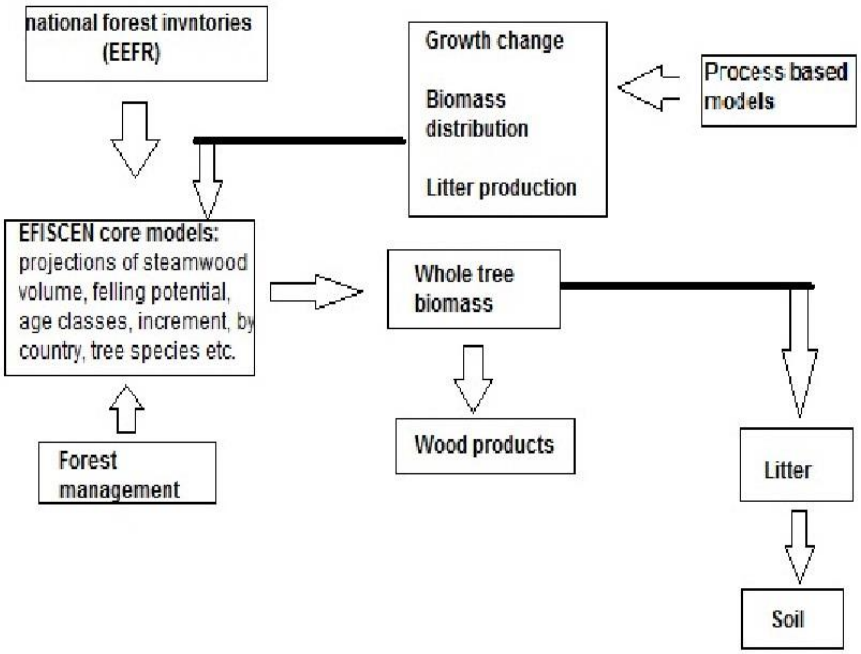



Figure 9

That could be done by using European forest information scenario (EFISCEN), that is a forest resource model suitable for large-scale (>10.000 ha) and long term (20-70 years) analysis of future development of forest resources in Europe. This model provides insight in increment, growing stock, age class distribution and actual harvest per tree species. The model is further developed and improved in EFISCEN 2.0. that incorporates transient changes in forest growth due to the climate change, as well as conversion of stem wood volumes to whole tree biomass carbon stock. The model is extended with inclusion of litter production, dynamic sub-models for soil carbon and wood products. Using already defined conversion ratios for different tree species in different age (Isaev), (figure 10)

Conversion ratios for phytomass carbon (Mg $m^{-3}$).

| Species | Age groups | | | |
|---|---|---|---|---|
| | Young stands | Middle aged | Premature | Mature/Overmature |
| Pine | 0.47 | 0.34 | 0.35 | 0.34 |
| Spruce | 0.55 | 0.37 | 0.36 | 0.38 |
| Fir | 0.39 | 0.32 | 0.27 | 0.29 |
| Larch | 0.51 | 0.48 | 0.52 | 0.51 |
| Cedar | 0.42 | 0.35 | 0.34 | 0.42 |
| Dwarf Siberian pine | 0.98 | 0.98 | 1.03 | 1.07 |
| High stem oak | 0.58 | 0.53 | 0.45 | 0.46 |
| Low stem oak | 0.89 | 0.54 | 0.62 | 0.73 |
| Beech | 0.47 | 0.51 | 0.49 | 0.49 |
| Ash | 0.51 | 0.50 | 0.42 | 0.43 |
| Birch | 0.48 | 0.41 | 0.37 | 0.37 |
| Aspen, poplar | 0.48 | 0.42 | 0.31 | 0.35 |
| Lime | 0.41 | 0.34 | 0.32 | 0.32 |
| Other softwood | 0.37 | 0.39 | 0.33 | 0.34 |

Figure 10

In order to evaluate the potential of Macedonian forests for carbon stock, it is necessary to spend a longer period (maybe a new project) that will give the real potential.

From 2008, the NGO “Day of the tree”, supported financially and logistically from the Government of Republic of Macedonia, Ministry for Agriculture, forestry and water economy, Public enterprise “Makedonski sumi”, Ministry of environment and physical planning, and other NGO’s and bodies, has started an action to afforestate bare, nonagricultural land in the state. For that purpose, the specific locations were selected, where in different years, different size and amount of seedlings were planted. The dynamic and amount of seedlings planted in different years (source PE “Makedonski sumi”) is shown in table 5.

Dynamic and amount of seedlings planted in the period 2008 – 2012 year

Table 5

| ***Afforestation by year*** | ***Afforested area (ha)*** | ***Number of seedlings*** | ***Survived*** | ***Number of seedlings by the highways*** |
|---|---|---|---|---|
| ***2008*** | ***2.580,90*** | ***5.259.220*** | ***57,50%*** | |
| ***2009*** | ***3.851,00*** | ***7.747.175*** | ***68,84%*** | |
| ***2010*** | ***2.077,70*** | ***7.645.454*** | ***57,73%*** | ***1.940.130*** |
| ***2011*** | ***981.13*** | ***3.431.063*** | ***/*** | ***600.000*** |
| ***2012*** | ***364,74*** | ***1.237.918*** | ***/*** | |
| ***Total*** | ***9.855,47*** | ***25.320.830*** | | ***2.540.130*** |

As it is shown, the total new afforested area during these 5 years is around 1% of the total forest area in Republic of Macedonia that is significant increment. This should improve the capacity of carbon sink, especially due to fact that these are young trees, with great growing capacity and productivity. The problem is with the species selection for the chosen locations. Mostly seedlings are from black pine (Pinus nigra), that is very sensitive on pest attacks, animal grazing and fires, and Cupressus arizonica, that is more suitable for those kind of environmental conditions (sub mediterranean climate, poor land, higher resistance on forest fires etc.). Most of the afforested area will be monocultures (1 to 3 species), that makes them very vulnerable on all factors of climate change. Very small area (mostly by the highways) is afforested with broadleaved species (mostly Robinia pseudoaccacia), in order to prevent landslides around and on the highways.

The adaptation capacity of the new forests will be very low, because of the unsuitable species selection of some seedlings, and very low maintenance activities (cleaning, watering, protection…) of new stands. If this action continues, there should be change of certain species, in order to increase the adaptation capacity of new forests.

**-Climate change impact on forest management and most vulnerable segments**

Definitely, the most significant impact on forest management in the period between Second and Third National communication had forest fires. Their impact has been recorded in the current year of their appearance but also in the next period due to post faire management activities that had to be done.

In the some years, due to extremely wet periods the ordinary works into the forest has been interrupted shortly but it is very difficult to find direct connection between this and climate change.

However, according to the climate scenario for Macedonia and our previous experience the follows segments of forest management will be most vulnerable till 2025:

1. Forest management planning: Due to all previously explained already happened and expected disturbances caused by climate change the planning of the forest management activities ( 10 years management period) will be very difficult. It is most likely that interventions into management plans and activities will be necessary.
2. Forest utilization: This sector will be also affected by climate change till 2025. Mainly due to activities which have to be done according to current laws (post fire management, insects' infestations, dieback process, infrastructure damages etc.) without economic justification.
3. Forest protection: Almost the same with forest utilization. Huge amount of finances will be spent to put under control fires, insects, monitoring of the health condition of the forest etc.
4. Hunting and tourism: Due to expected disturbances of the forest till 2025 (fires, dieback process etc.) wild animal populations will be under threat. Also as consequence of these disturbance tourism value of the forest well decrease.

5. Silviculture: Many of forest management activities and technics are long term activities (for 20 to 60 years period, sometimes more). It means that they have to be changed and harmonized with the new conditions due to the climate change.
6. Land use changes are not expected to occur in the forestry sector, at least not permanent ones, due to the obligations of the Forest law. There should occur some temporary land use changes, as a result of forest fires and clear cuts, but they will be eliminated in the next 3-5 years after occurring. There is a trend of land use change in the mountain areas, where the villages are abandoned, and the previous agricultural land is conquered by forests.

## Action plan - Forestry

| **Action** (adaptation measures that will maximize the economic benefit and minimize the climate change impact per sector) | **Type** Policy Legislation Capacity building … | **Stakeholders** (Clear distinction of responsibilities among the relevant stakeholders) | **Timeframe** Short term/long term | **Financing** (Financial means for implementation of the measures) -Euro- | **Constraints** (Identification of possible barriers and risks, including legal arrangements, institutional management, financial and technological aspects) | **Sectorial /institutional relationship** |
|---|---|---|---|---|---|---|
| 1. Develop program for adapting forestry to global climate change | Policy, Capacity building | FFS, MAFWE, PEMF | Short term | 150 000 | Capacity, finance, sector coordination | Agriculture, Ecology, Energy, |
| 2. Adaptation of the Management plans in the forestry in agreement with the climate change | Legislation, Capacity building | FFS, MAFWE, PEMF | Long term | 300 000 | Law of forestry, education of stuff, lack of finance | Ecology, Energy |
| 3. Establishment of 5 monitoring stations in forests regions for following of the climate changes | Capacity building | FFS, MAFWE, PEMF, NHSRM | Short term | 600 000 | Financial and technological | NHSRM, Ecology |
| 4. Introduction of technologies for efficient biomass using in the forestry | Legislation, Capacity building | FFS, MAFWE, PEMF | Long term | 1 000 000 | Educational, financial, technological, legal | Environment, Energy, |
| 5. Purchasing of proper vehicles and equipment for forest fires suppression (early response - first attack) | Capacity building | FFS, MAFWE, PEMF | Short term | 1 200 000 | Financial | Environment, forestry |
| 6. Develop educational (training) centre for sustainable forest utilization | Capacity building | FFS, MAFWE, PEMF | Short term | 500 000 | Financial and technological | Forestry, Ecology |
| 7. Promotion of the possibilities for production of “green | Promotion, Legislation, | FFS,FASF, MAFWE, PEMF,ME, MOEPP | Long term | 100 000 | Financial, institutional | Energy, Ecology |

| | | | | | | |
|---|---|---|---|---|---|---|
| energy” | Capacity building | | | | | |
| 8. Implementation of pilot project for renewable energy production from forest and agricultural biomass | Legislation, Capacity building | FFS,FASF, MAFWE, PEMF,ME, MOEPP | Long term | 10 000 000 | Financial, institutional, technological, legal,… | Ecology, Energy, Agriculture |
| 9. Biomass Stocking (last one was done in 1977) | Data gathering | FFS, MAFWE, MOEPP | Short term | 150 000 | Financial | Data needed for higher Tier calculations: annual biomass growth (all types of forests, grasslands, croplands), DOM, Carbon fraction of biomass, Fraction of biomass oxidized Fraction of biomass burnt on-site and off-site, Fraction of biomass left to decay, harvest of industrial roundwood (logs) and fuelwood, production and use of wood commodities, and establishment and operation of forest plantations as well as planting of trees in urban, village and other non-forest locations |

Abbreviations

| | |
|---|---|
| MAFWE | Ministry of Agriculture, Forestry and Water Economy |
| MOEPP | Ministry of Environment and Physical Planning |
| FFS | Faculty of Forestry Skopje |
| FASF | Faculty for Agricultural science and Food |
| NHS | National Hidrometeorological Service |