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Collaborative Project

CLIM-RUN

Climate Local Information in the Mediterranean region Responding to User Needs

WP 6 – Wild Fires Case Study
Task 6.1 - Organization of periodic meetings and surveys

Deliverable 6.1

Workshop report: context and objectives, confrontation of data supply and demand, simulation results, feedback and discussion.

Project No. 265192– CLIM-RUN

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Table of Contents

1. Introduction

The work package WP6 focuses on the analysis of the climate information required in areas where forest fires represent a major hazard. This package will evaluate future fire risk in the Mediterranean and in specific target regions (mainly Greece) for the next 10 to 50 years. The WP will illustrate how climate information can play an important role in the identification of vulnerable regions and in the management of existing and new forests.
As a first step, bearing in mind that the CLIMRUN project has adopted the method of an active participation early in the research on behalf of the end users, a workshop with the stakeholders was organized.
In this deliverable we outline the results of the workshop, held in Athens on September 28, 2011, and we also give the results of a questionnaire which was filled during the workshop.

2. The stakeholders workshop

The first workshop for the wild fires case study entitled "Effects of Climate Change on Forest Fires and Forest Ecosystems", took place on September 28, 2011 at the premises of the National Observatory of Athens (NOA). The workshop was held in the Greek language. The conference brought together 16 academics and representatives from the public and private sector, involved in the fields of forest fires and ecosystems.

Out of the 18 stakeholders invited, 16 of them responded positively to the invitation, and 9 of them made a brief presentation of their activities. The list of the participants together with their affiliations can be found in **Table 1**.

It is important to note that presentations covered a wide spectrum of interests, yet all of them had inter-connected or even overlapping fields of research and applications, which resulted in extensive discussions during and after the presentations. The arrangement of the presentations followed the programme given in Annex 6.1. .During the coffee break and at the end of the workshop, participants had the opportunity to fill in a perception questionnaire originally prepared for CLIMRUN and adapted for the forest fires case studies by NOA (annex 6.2).

Immediately after registration, presentations started with the welcoming of the participants by Christos Giannakopoulos. He made a brief introduction to the CLIMRUN project, presenting key stages of the project and explaining the concept of climate services. Subsequently, he gave an overview of the goals of the project always in close collaboration with the stakeholders.
Immediately afterwards, Christos Giannakopoulos also presented some background information about climate change in the Greek territory. Using data from a regional climate model, he presented changes in selected climate indices related to temperature and precipitation.

Afterwards, Anna Karali and Anargyros Roussos, both members of the NOA team, presented the evaluation of present and future fire risk in Greece. Key points in the specific presentation, was the statistical processing and data analysis of forest fires in Greece, the evaluation of the Canadian Fire Danger Index (FWI) for Southern Greece and future projections of fire risk. More specifically, the statistical analysis covered spatial and temporal distribution of forest fires in Greece in the period 1991-1997. In connection to this analysis, an evaluation of FWI was performed and new thresholds for elevated and extreme fire risk were established. Finally, through the use of regional climate model projections for the near (2021-2050) and distant (2071-2100) future, an estimation of the fire risk for

these periods was produced. The findings suggested a general increase in fire risk, reaching up to 30 more days of extreme fire risk annually in specific regions, by the end of the century.

Figure 1: Workshop Presentations

The next presentation, given by Irene Nikolaou, referred to the challenge of forest adaptation to climate change. At first, she presented an overview of the current state of Greek forests. She gave her point of view on how forests affect climate and how climate change affects the Greek forests. She went on by giving a preliminary view of the initial planning of the Greek national forest adaptation policy, which mainly consists of the following steps:

- To monitor the dieback and the health situation of the forests
- To enhance the enforcement of the sustainable forest management
- To adapt the forest management (aims, silvicultural methods etc.) to climate change

- To develop a small group of skilful personnel in the forest public sector targeted to several groups starting from school ages, for education on sustainable forest management and public awareness on the impacts of climate change and desertification (Forest Pedagogy).

She concluded by giving the future steps of the forest adaptation to climate change, summarizing all important actions to fulfil this task.

Next on presentations, Mr Iordanis Tzamtzis gave an assessment of forest fire risks and innovative strategies for fire prevention. His presentation concluded that:

- Forest fire prevention should be promoted as an integral part of sustainable forest management
- Current attention to the role of forests in climate change should be used to raise awareness about the risks of forest fires and the need for preventive measures

Therefore, it was proposed that the following measures should be taken:

- Improve cooperation between different bodies/working groups
- Strengthen harmonized data collection and sharing of experiences across countries
- Fire prevention to be integrated in adaptation strategies
- A common understanding of forest fire prevention (definition, activities) is needed

Following this presentation, Dr. Gavriil Xanthopoulos presented forest fire encounter strategies in a climate change framework. He noted that, developing a strategy to manage the forest fire problem, mitigating its consequences, requires an understanding of the reasons that made it become worse in the last few decades and mentioned briefly these reasons based on Greek and international literature. Continuing he supported that the new strategy must be based on scientific knowledge on forest fires as much as possible in order to avoid pitfalls. It should recognize the ecological role of fire, the importance of fire prevention and the need to control forest fuel accumulation. Fire suppression should become both effective and efficient. The use of aerial firefighting resources which is very expensive should be reconsidered in order to achieve the best performance/price ratio. All relevant organizations should be asked to contribute according to their knowledge, personnel, equipment and specialization in order to succeed on managing the worsening fire problem under potentially serious budget cuts. Dependable fire danger prediction is the key to efficient organization as it can help save costs by mobilizing all involved organizations only when it is really needed. Finally, dependable fire statistics should be collected and analyzed in order to evaluate results and guide future improvements.

Next presentation was given by Mrs Konstantina Tsagari referring to the time series analysis of changes in forest fires and climate on forest ecosystems in Greece.
The work employed meteorological data originating from nine (9) stations located inside forest areas and analyzed the monthly, seasonal and annual variation of meteorological parameters such as rainfall, minimum (Tmin), maximum (Tmax) and average (Tmean) temperature, covering the time period 1960-2006. On an annual basis, the minimum and average temperature tends to decrease, contrary to the maximum temperature that tends to increase. On a seasonal basis, Tmean and Tmin are declining in most stations, but Tmax is nearly constant in all seasons except summer, when it increases. Furthermore, there is a statistically significant increase of water stress at low altitudes and at higher prevailing favourable water conditions than before, and also the Tmean and Tmin show no statistically significant upward trends while the Tmax shows in Southern Greece. Then, she presented a time series analysis of fire data for the period 1983 – 2008 period, focusing on three main parameters: number of fires, burnt area and fire severity (burnt area per fire).

As an overall conclusion, the sizes of forest fires have an increasing trend over the past few years, but this trend has a large spatial variability and depends on many factors other than climate conditions such as poor forest management, forest service structural problems, reduction of funds for prevention, abandonment of rural activities, structural inconsistencies of the suppression mechanism, etc.
A reliable assessment of the impacts of climate change on forest ecosystems requires a continuous and uninterrupted recording of reliable data (both meteorological and fire data).

After coffee break, Mr Nicholas Georgiadis, took the floor and made a short speech about the contribution of WWF-Greece to the protection of forest ecosystems, towards their "smooth" adaptation to climate change. This contribution falls in the following areas:

- Rapid assessment of important forest fires
- Overall monitoring of burned sites in the Peloponnese and land use changes in Greece
- GIS based prediction model of natural forest regeneration in Ilia (Peloponnese)
- Monitoring of unburned forest patches
- Species project

Following this presentation, George Mahairas, dealt with the issues of prevention, repression and the rehabilitation of forest fires based on his five year experience in the Attica (greater Athens) region.
In general, the presentation was an overview of all structural changes that took place in the broader area of Forest management, in the last two decades. That is, the transaction of the fire suppression responsibility from Forest Service to the Fire Service, and the inconsistencies of the suppression mechanism that had to be dealt with due to this transaction. Also the administration gaps of fire prevention and suppression mechanisms that become more evident during specific fire events.

Afterwards, Mr Evangelos Chatzinikos gave his views on sustainable hunting and the biodiversity protection. He mentioned that, hunters constitute a well organized community that preserves and manages large areas of the countryside and have a deep awareness of their responsibilities regarding sustainable hunting of game species and the protection of nature and wildlife. He concluded that continuous scientific monitoring of the populations of game species as well as the phenology of migration of waterfowl birds at a national level constitute a basic priority for the Greek hunting federations as they provide the sustainable management of game species.

The following presentation of Nikolaos Fyllas, partner in EU FUME project, focused on the simulations of climate change impacts on forest ecosystems dynamics. Specifically, he described the vegetation dynamics models (VGMs) tailored to the Greek forest sector. All VGMs use plant functional groupings for the approximately 30 dominant species in Greece to categorize their response to environmental drivers and disturbance. Special interest has been paid to the role of fire in regulating forest dynamics under current and climate change scenarios.He pointed out, that downscaled climatic reconstructions and climate change scenarios data will be necessary in order to develop integrated models that better represent both atmospheric and biospheric processes and more accurately quantify vegetation responses and feedbacks to climatic changes.

The last presentation was given by Themistoklis Sbarounis, from the Argyroupolis Centre for Environmental Education (ACEE). He presented the Forest Fires: Causes, Prevention, Landscape rehabilitation programme, which is addressed to students of primary and secondary schools as well as teachers and adults. The cognitive objectives of the programme include: the knowledge of the structure and the function of Mediterranean Type Ecosystems (MTE), the role of fire as an evolutionary factor

of MTE as well as a disturbance and stress factor, the several causes of forest fires and their categorization, prevention measures, means of effective response and post-fire management measures aiming to the rehabilitation of the landscape.

Table 1: Workshop participants

Name	Institution	E-MAIL
Dr. Gavriil Xanthopoulos	*Institute of Mediterranean Forest Ecosystems and Forest Products Technology, NAGREF*	gxnrtc@fria.gr
Dr. Nikolaos Fyllas	*University of Athens , Faculty of Biology Dept of Ecology & Systematics*	nfyllas@gmail.com
Dr. Michael Xanthakis	*Management Body of Mount Ainos National Park*	mxanthakis@yahoo.com
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George Machairas	*Forest Service of Piraeus*	m_yorgos@hotmail.com
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Iordanis Tzamtzis	*Forester - Environmental Scientist*	Itzamtzis@gmail.com
Markos Gkouvas	*Fire Service*	markosgk1@gmail.com
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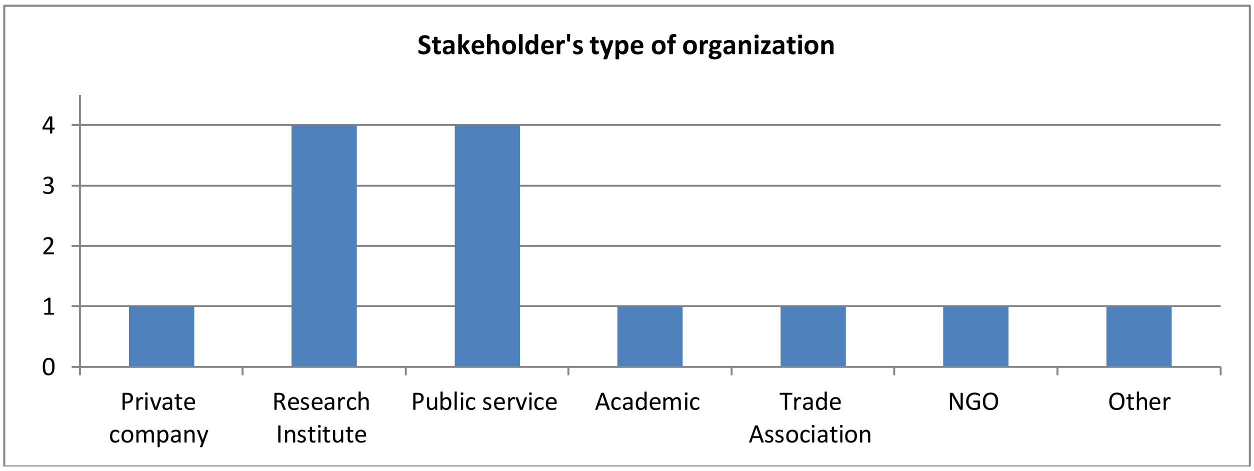
Dr. Konstantina Tsaggari		contsagari@fria.gr
Dr. George Karetsos		Kage@fria.gr
Nicholas Georgiades	*WWF Greece*	n.georgiadis@wwf.gr
Charis Rouchotas	*Hellenic Timber Association*	harry@teak.gr
John Albanis		president@htca.gr

3. Analysis of Questionnaire Results

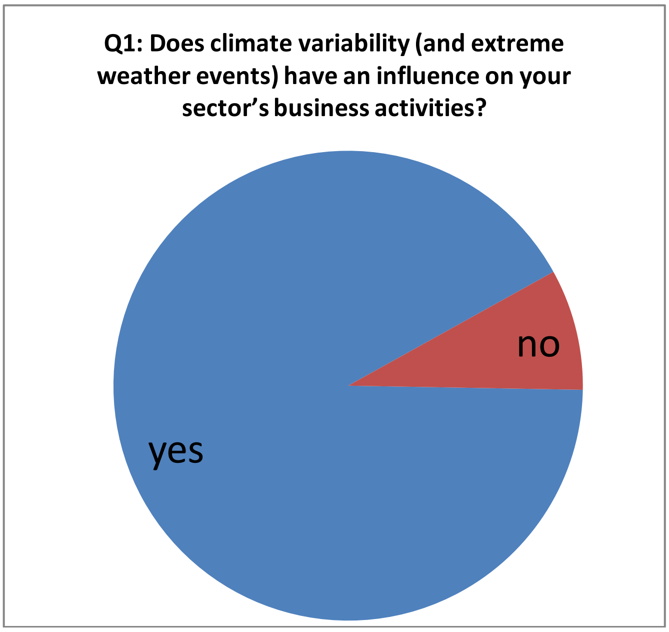
During the coffee break of the workshop, the participants were requested to fill in a questionnaire concerning their perspective on climate change and how this change can affect their current or future activities. They were also asked to supply information on their current and future needs on climate data. A copy of the questionnaire is added as an annex to this report.

The participant's profile revealed that they were employed in a wide variety of professional domains. Almost half of the people that answered the questionnaire were involved in the academic / research area, as shown in Graph 1.



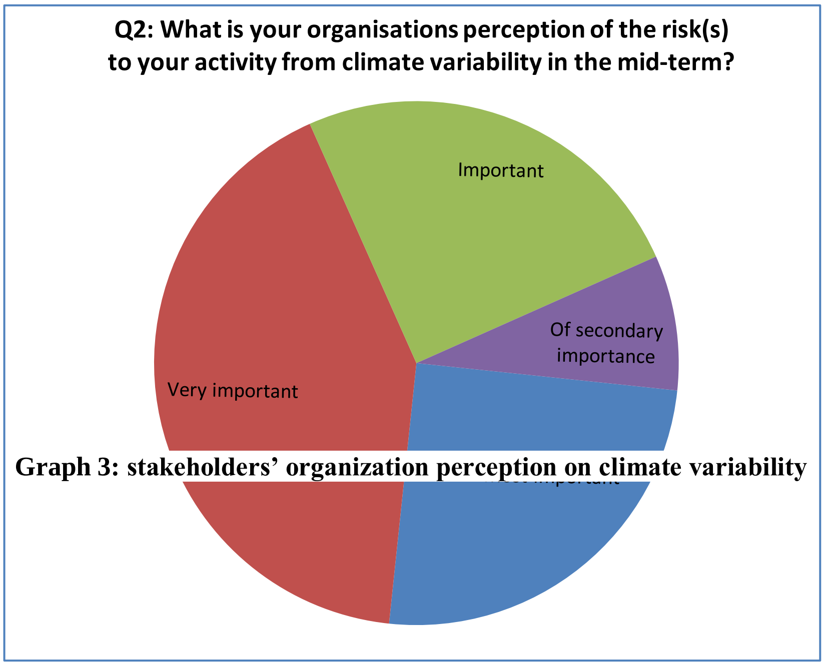
Graph 1: the distribution of Stakeholders in the various organization types

As seen in Graph 2, an extremely high percentage of the stakeholders believes that climate variability does affect their current research or professional activities. This means that most of the participants are highly concerned about future climate change, and its potential impacts for their sector's business activities.



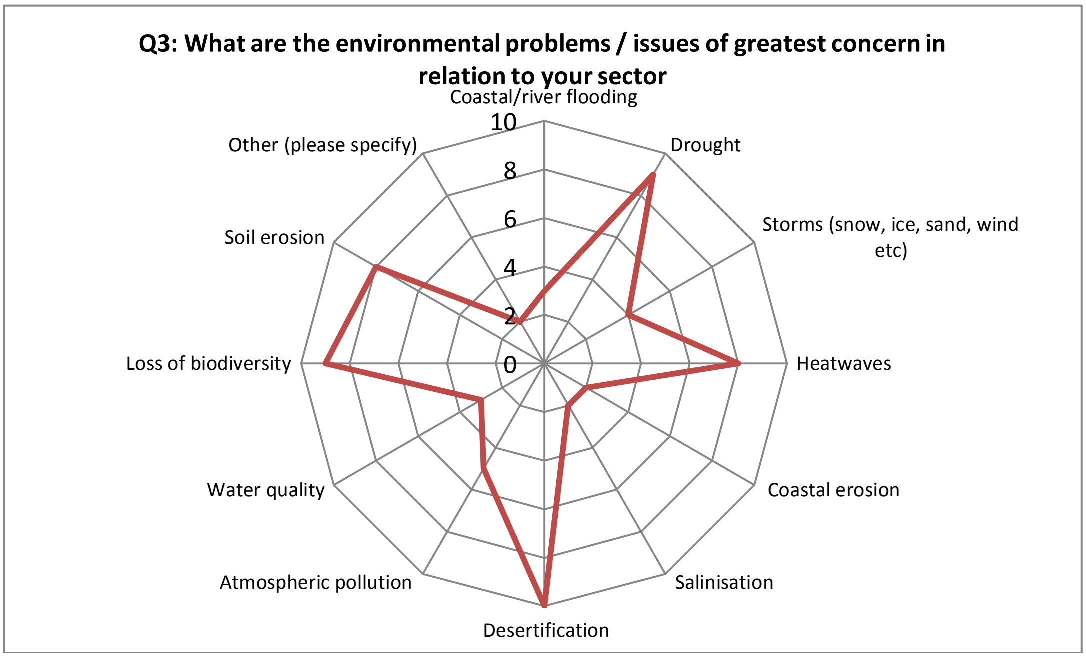
Graph 2: stakeholders' opinion on climate's variability influence

Combining this result with the wide variety of scientific and professional aspects seen in the previous question results, it is understood that climate variability affects a wide variety of professional activities and research fields.

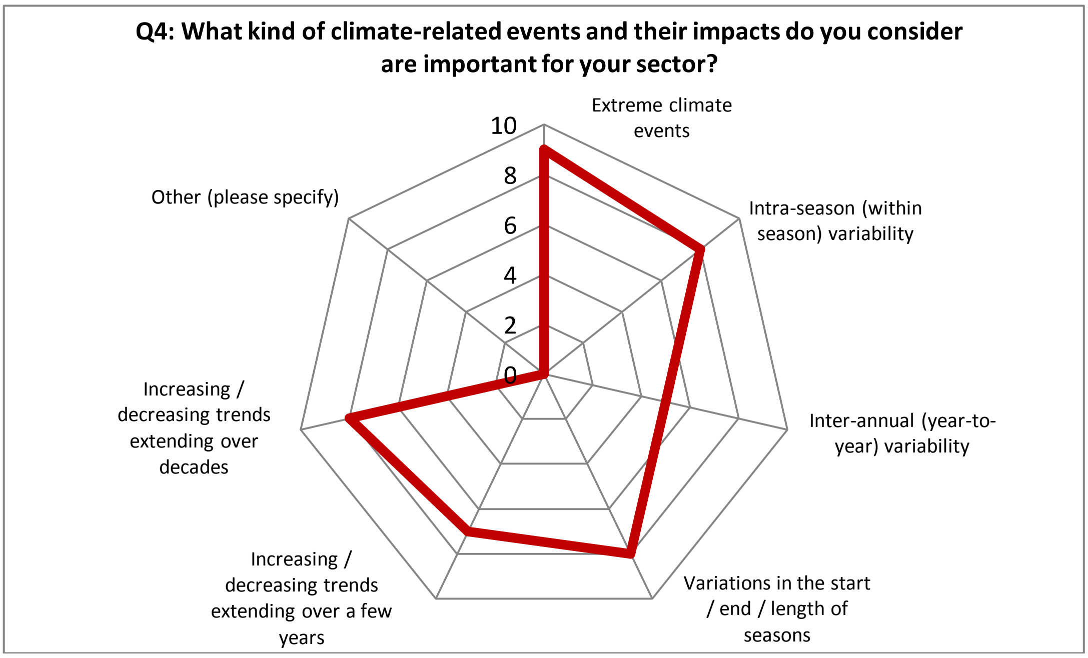


Graph 3: stakeholders' organization perception on climate variability

As seen in next question depicted on Graph 3, most of the participants consider that climate variability will affect their activities in the midterm, expressing also the opinion of their organizations. This reflects the fact that most of them have been coping with climate change related phenomena for some time already.
It is also a fact that certain impacts of climate change, such as desertification, biodiversity loss and drought affect the majority of scientific fields and professional sectors participating in the workshop, as seen in the answers given in question 3 of the questionnaire, depicted in Graph 4. It is also important to notice that soil loss and heat waves affect significantly a great number of the participants, who also noted forest fires and the exhaustion of agricultural and / or forest lands as "other" problems.

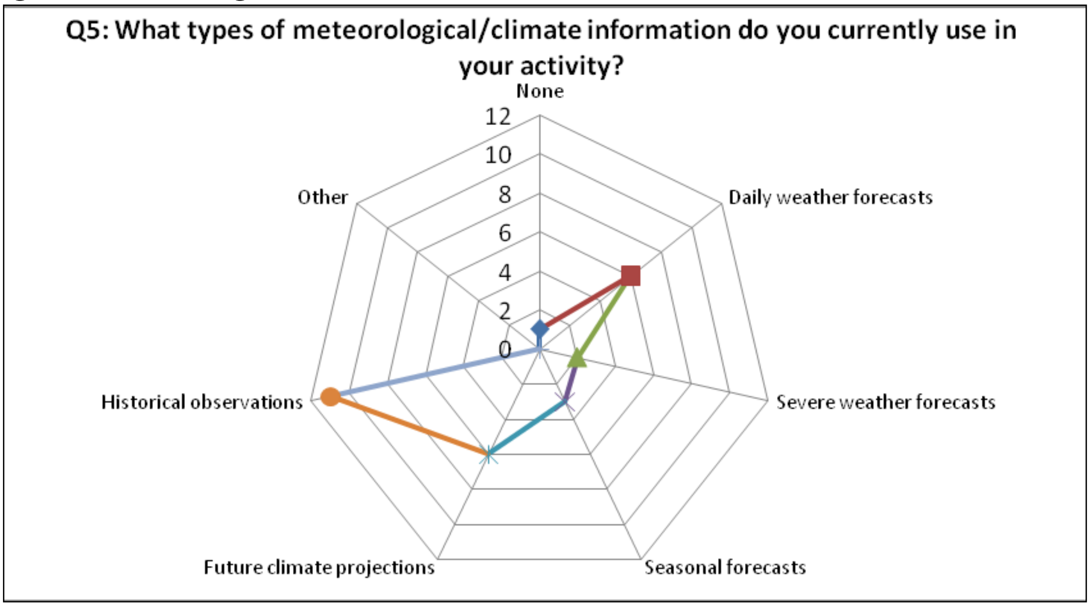


Graph 4: Environmental issues of greatest concern, according to workshop participants



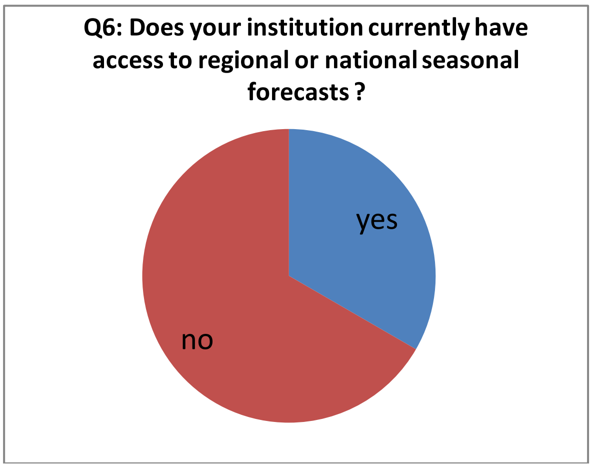
Graph 5: stakeholders' view on the importance of climate related events

On the other hand (Graph 5), no major differences were depicted regarding participants' opinions on the events that related to climate and its importance to their sector. That is, extreme climate events, such as heavy rainfall, high and low temperatures, heatwaves, drought, flood or hail, were voted as most likely to affect stakeholders' sectors. Also equally important were found to be increasing or decreasing trends extending over decades.

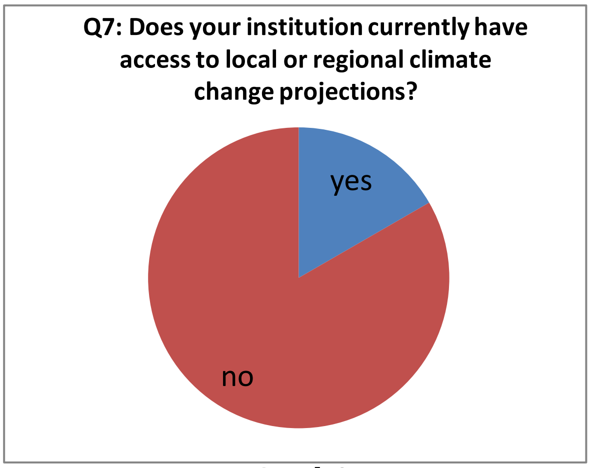


Graph 6: stakeholders' current weather data needs

As seen in Graph 6, most of the workshop participants use historical data rather than daily weather forecasts or future climate projections. This comes as a consequence of the fact depicted in graphs 7 and 8, that most of their organizations do not have access to regional or national forecasts as well as climate change projections. This could mean that due to lack of forecast data and climate projections, they use historical observations for their research applications.



Graph 7

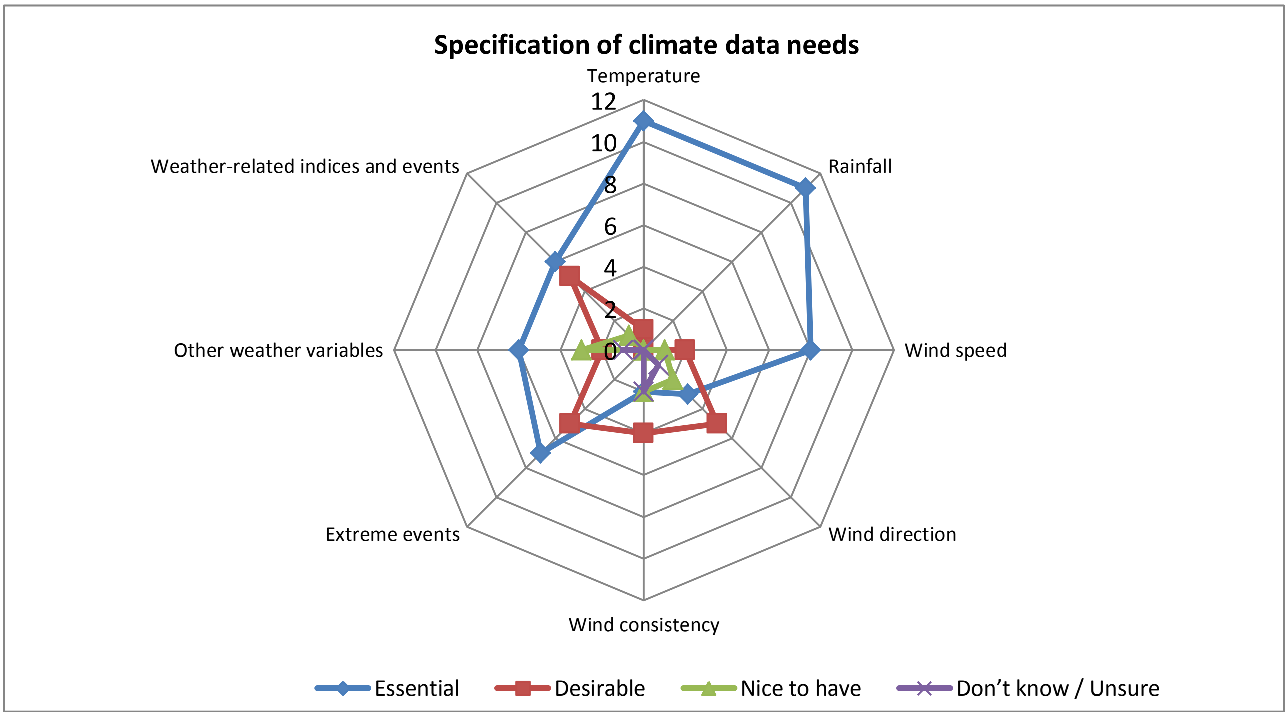


Graph 8

In the questionnaire questions that followed, the participants stated that current variability in weather and climate seems to affect most of their current applications at many levels. For instance, extreme weather events may prevent various outdoor activities, as well as affect the characteristics (ignition, rate of spread and intensity) of forest fires and other natural hazards. Such extreme weather conditions affect the plant phenology and therefore may lead to incorrect measurements through climate alterations and variations.

Current climate trends projected into the near future make the participants worry practically about the same issues, with some extra concern placed towards the decrease of the extent of certain plant species, which would consequently lead to land degradation or even desertification. Of course, the fact that climate is getting warmer is a strong indication that forest fires in the future will be more frequent and intense.

Greater knowledge and understanding of climate variability was seen quite positively by the majority of the participants. That is, greater knowledge on future climate conditions will provide them with the ability to understand and implement various models on their applications. Such applications can be education, research or the public services responsible for Forest and Environmental Management.



Graph 9: User needs on climate data

From graph 9, it is obvious that most of the participants consider temperature and precipitation essential to their work, as well as wind speed or extreme events. Other kinds of data are essential to some, desirable to others, such as weather related indices and events. Data on wind direction and consistency are considered just desirable. Common ground amongst participants on this question is the high level of confidence concerning their answers.

4. Stakeholder presentations

4.1.Future climate projections for Greece

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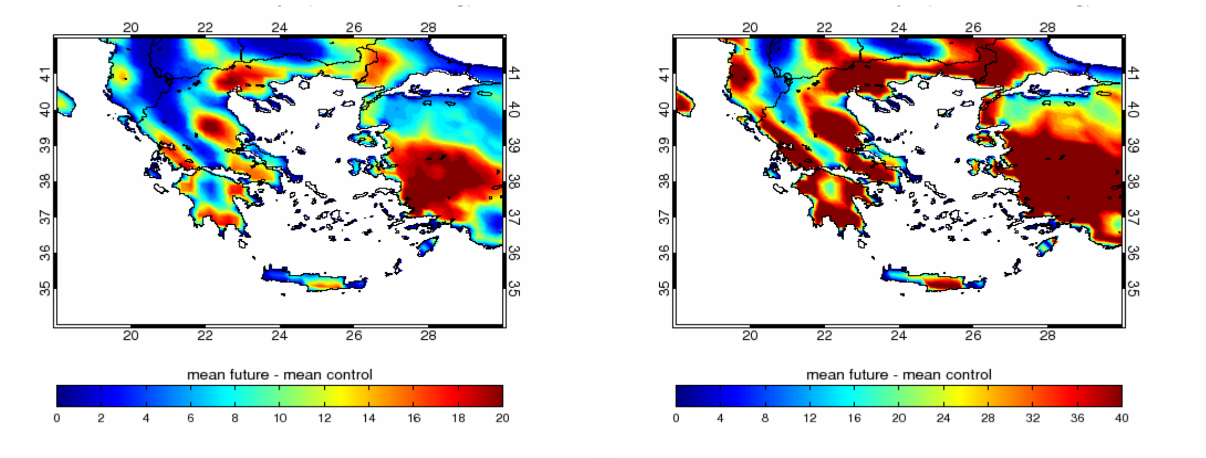
Introduction

Changes in the occurrence of extreme weather events might have a stronger impact on climate than a longer-term change in the “average” climate, as a change in the mean value might bring about a disproportionate, non-linear effect on the fraction of extremes beyond certain critical thresholds.
In the study, data from the RACMO2 regional climate model were used, developed by the Royal Meteorological Institute of the Netherlands (KNMI), with a horizontal resolution of 0.25 degrees (around 25 km). The data from the model were created within the framework of the ENSEMBLES Community programme (www.ensembles-eu.org), where the National Observatory of Athens participated. The aim of the project was the study of climate change in Europe and the quantification of uncertainty in climate projections. The specific model was selected because, during an assessment exercise of all the models which formed the basis of the simulations within the framework of the ENSEMBLES programme, it was found that RACMO2 simulates temperature and rainfall extremes more accurately. The data cover a baseline period of 30 years, 1961-1990, i.e. for the current climate and two future periods, 2021-2050 and 2071-2100, in order to study climate change on the basis of Scenario A1B of IPCC. Changes in relevant climate indices between each future period (2021-2050 and 2071-2100) and the baseline period (1961-1990) are computed. The first future period, 2021-2050, was specifically chosen for the needs of policy makers, so as to help planning in the near future, while the second period, 2071-2100, was selected to bring to the fore the range of changes at the end of the-21st century (Giannakopoulos et al., 2011).

Results

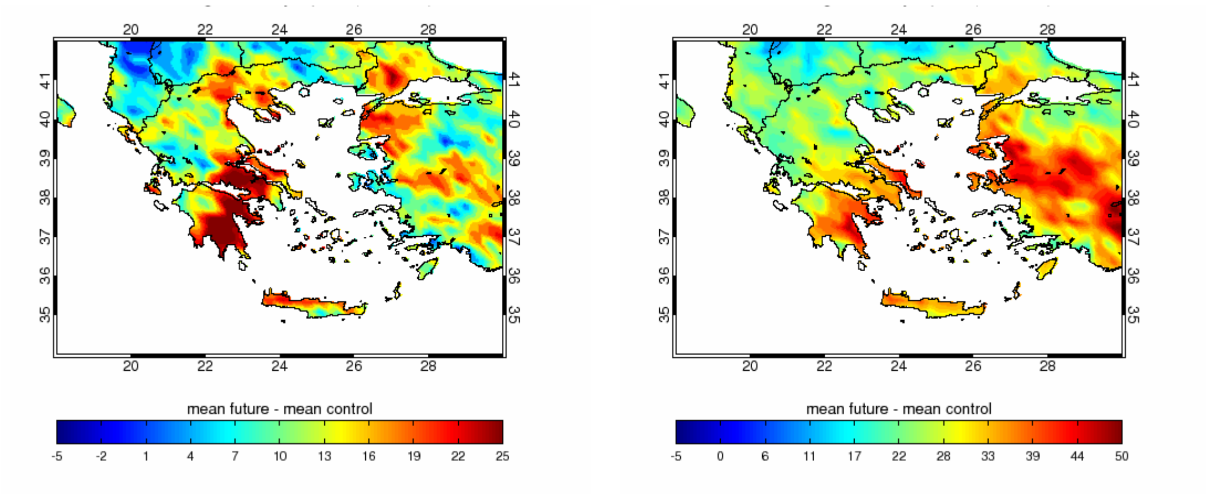
Figure 1 depicts projected changes in the number of days with temperatures over 35^{o}C. These changes are expected to have a significant effect on population discomfort, particularly in urban areas. It is obvious that the number of days with temperatures over 35^{o}C increases throughout the country. The most noticeable changes are evident in the low-lying areas of continental Greece, in eastern Central Greece , Thessaly, South Peloponnese and Central Macedonia, where up to 20 additional “very warm” days are expected for 2021-2050 and up to 40 for 2071-2100 on an annual basis (compared with the “very warm” days of the baseline period 1961-1990). Changes in Crete and Attica should be milder, as the increase in the number of “very hot” days should not exceed 15 additional days in 2021-2050 and 30 additional days in 2071-2100. The increase in the expected “very hot” days in the Aegean and the Ionian islands should be smaller, with 10 additional days in 2021-2050 and 15 additional days in 2071-2100. This is natural, due to the effects of the nearby sea and the sea breeze, which play a dominant role in tampering the excess summer heat.



(α) (β)

Figure 1 *Changes in the number of days with maximum temperature > 35ºC between (a) 2021-2050 and 1961-1990, and (b) 2071-2100 and 1961-1990.*

Furthermore, projected changes in the duration of drought periods are presented, i.e. changes in the duration of constant days with rainfalls less than 1 mm a day. Figure 2 shows that the duration of drought periods increases. The smallest variation, less than 10 additional days, is observed over the western regions in 2021-2050. In 2071-2100, increases in western and northern Greece should be less than 20 additional days. The strongest increases are observed in eastern continental regions (eastern Central Greece , eastern Peloponnese and Evia) and northern Crete, where more than 20 additional drought days are projected by 2021-2050 and up to 40 additional drought days by 2071-2100.



(α) (β)

Figure 2 *Changes in the maximum duration of the dry period (in days) between (a) 2021-2050 and 1961-1990, (b) 2071-2100 and 1961-1990.*

References

Giannakopoulos C., E. Kostopoulou, K.V. Varotsos, K. Tziotziou, A. Plitharas, An integrated assessment of climate change impacts for Greece in the near future, Reg. Environ. Change, DOI 10.1007/s10113-011-0219-8, 2011

4.2.Evaluating present and future fire risk in Greece

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Introduction

Forest fires have always been present in the Mediterranean ecosystems. Throughout history, human induced or naturally caused forest fires imposed their impact on natural environment. The last few decades though, the number of forest fires has significantly increased, as well as their severity and impact on the environment. An average of 50,000 fires sweep away from 700x103 to 1000x103 ha of Mediterranean forests per annum (FAO 2007), causing enormous economic and ecological destruction. In particular, the data collected reveal that, according to the average burnt area per fire, Greece has the most severe forest fire problems among the European Union countries (EU 2001). It has been estimated that the average area burnt per fire was 39.4 ha in Greece, 28.47 ha in Spain, 19.74 in Italy and 15.29 in Portugal (Iliadis et al. 2002).

Forest fires are highly sensitive to climate change because fire behavior responds immediately to fuel moisture (Weber and Flannigan 1997; Stocks et al. 2001). Thus, the projected increase in temperature will increase fuel dryness and reduce relative humidity and this effect will worsen in those regions where rainfall decreases. Accordingly, increases in climate extreme events are expected to have a great impact on forest fire vulnerability (Beniston 2003).

The contribution of meteorological factors to fire risk is simulated by various non-dimensional indices of fire risk. Viegas et al. (1999) validated several such indices in the Mediterranean against observed fire occurrence, with the Canadian Fire Weather Index (FWI, van Wagner 1987) amongst the best performers. The FWI model is non-dimensional, based on physical processes and has been used in many different locations, therefore it seems a sensible basis for exploring the mechanisms of fire risk change.

In this study, an evaluation of the index applied to current fire data for Greece is performed with particular emphasis on the most vulnerable region of Southern Greece. The study aims to establish whether FWI values can adequately reflect fire risk as judged by actual fire occurrence and to estimate the potential projected changes in fire risk.

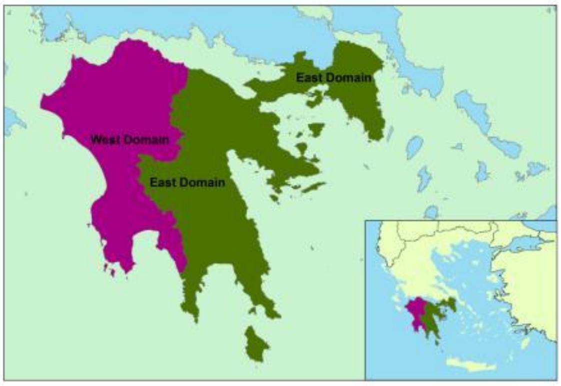
Data and Methods

In our study, the fire data were provided by the Forest Special Secretariat of the Ministry of Environment, Energy & Climate Change. Fire data concern inventory of forest fires that occurred in the period 1991-1997 throughout Greece.

Meteorological data covering the 7-year period (1991-1997) were obtained from the Hellenic National Meteorological Service. Mean daily values from two stations (Elliniko-37° 44' N. 23° 44' E, Kalamata-37° 04' N. 22° 10' E) were used in order to compute daily values of FWI.

Due to the different meteorological conditions prevailing in the eastern and western areas of Southern Greece, the domain of interest was split into two parts covering the eastern Peloponnese and the Attica Peninsula (Eastern Domain) and the western Peloponnese (Western Domain). Forest fire risk was assessed using the Canadian Fire Weather Index (FWI). FWI is a daily meteorological-based index used worldwide to estimate fire danger in a generalized fuel type. Although it has been developed for Canadian forests, several studies have shown its suitability for the Mediterranean basin (Moriondo et al. 2006). The FWI System provides numerical ratings of relative fire potential based solely on weather observations. FWI components depend on daily noon measurements of dry-bulb temperature, air relative humidity, 10m open wind speed and 24 h accumulated precipitation and are described in detail in van Wagner (1987).

Figure 1: Map of Southern Greece, where the two domains are displayed.



FWI consists of 6 standard components each measuring a different aspect of fire danger. The first three are fuel moisture codes that follow daily changes in the moisture contents of three classes of forest fuel with different drying rates. The remaining components are fire behavior indices representing the rate of spread, fuel weight consumed and fire intensity.

Results

Forest fire records and FWI validation

The following table concerns cumulative data on burnt area and the number of fires occurred in the eastern and western domain respectively on each year in the period 1991-1997.

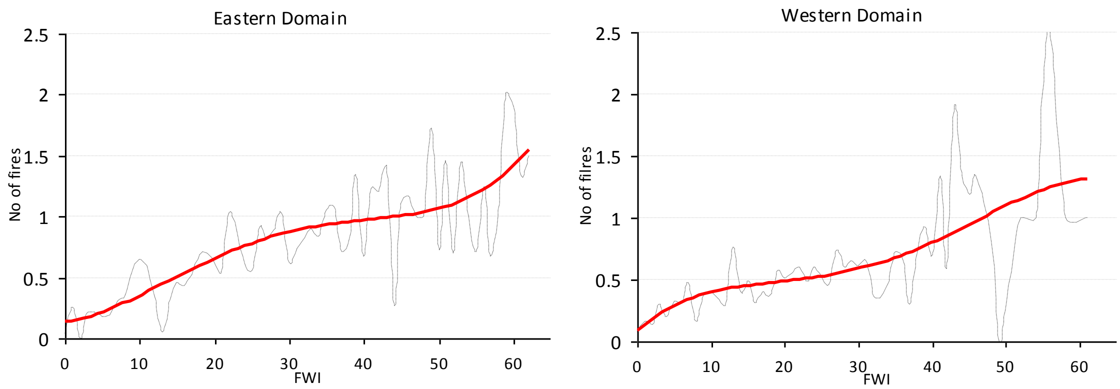
Table 1: Burnt area and number of fires per year for the Eastern and the Western Domain during 1991-1997 period.

	Burnt Area (ha)		Number of fires	
	Eastern Domain	Western Domain	Eastern Domain	Western Domain
1991	2668,9	570,6	119	91
1992	28436,5	5652,8	312	224
1993	13486,6	6754	301	292
1994	3567,1	2495,7	212	182
1995	4367,3	3768,2	188	214
1996	4643,2	1040,9	162	146
1997	2307	3355,8	138	239
Total	**59476,6**	**23638**	**1432**	**1388**

The table depicts an almost total predominance in burnt area and the number of fires of the Eastern Domain. That is due to several factors, such as the larger extent of the Eastern Domain, population, the density of infrastructure and the climate. Most fires are caused by human activities, deliberately or by negligence (Pausas & Vallejo, 1999), and in this way it is expected to have more fire events on a highly populated area.

The FWI was classified in categories of bin with size 1 and the average value of the number of fires that occurred at each category was calculated for both domains (Figure 2). It should be noted that the increased variability in high FWI values results from the decrease in the frequency of occurrence of high index values. The best estimated polynomial fit was applied on the data. The turning points of both fitted equations were calculated at FWI ≈ 15 and FWI ≈ 45. This implies that at FWI ≈ 15 the fire risk is starting to increase and one fire in two days occurs when FWI ≈ 15. The FWI ≈ 45 value indicates extreme fire risk, while one fire occurs in each day with FWI ≈ 45. These values are in accordance with Moriondo et al. (2006) and Good et al. (2008) that resulted at the same threshold values with different methodologies. Therefore, FWI ≈ 15 and FWI ≈ 45 are set as thresholds for elevated and extreme fire risk, respectively.

Figure 2: Mean number of fires per day against FWI (black line) and the respective polyonimal fit (red line) for the Eastern (left) and the Western Domain (right) for 1991-1997 period.

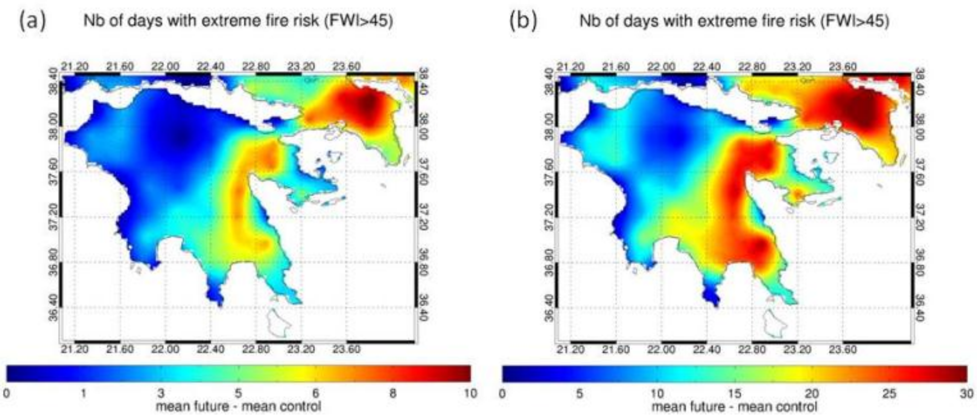


Future projections

Present and future model data from the Regional Climate Model RACMO2 were used in this study. The model was developed within the framework of the ENSEMBLES Project, by the Royal Netherlands Meteorological Institute (KNMI), at 25km horizontal resolution. The control run represents the base period 1961-1990 and is used here as reference for comparison with future projections for the periods 2021-2050 and 2071-2100. For the study region, maps produced illustrating the change in the number of days with extreme fire risk (FWI>45) between the reference and the two future periods (Figure 3).

In the near future, namely 2021-2050, the most considerable increases are estimated in the eastern part of Peloponnese and the greater part of Attica with up to7 and 10 more days of fire risk per year, respectively (Fig 3a).On the other hand, by the end of the century (2071-2100), most part of the Eastern Domain may experience increases of up to 30 days per year, with the Attica Peninsula being the most vulnerable part of the domain. Smaller increases of up to 12 days may occur on the Western Domain (Fig 3b).

Figure 3: Projected changes in the number of days with extreme fire risk (FWI>45) during (a) the first future period (2021-2050) and (b) the second future period 2071-2100.



Conclusions

FWI was confirmed to be skillful at predicting fire occurrence for the vulnerable area of Southern Greece. The resulted thresholds FWI ≈ 15 and FWI ≈ 45 for elevated and extreme fire risk, respectively, are in accordance with Moriondo et al. (2006) and Good et al. (2008).

The future projections suggest a general increase in fire risk over the domain of interest with a very strong impact in the eastern Peloponnese and Attica. For the near-future period 2021-2050, the number of days with extreme fire risk increases up to 10 more days per year in the eastern part of the study area. By the end of the century (2071-2100), the increase is 12 and 30 days in the Western and Eastern Domain, respectively.

Acknowledgement

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4.3.The challenge of adaptation to climate change

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Introduction

Climate change consists one of the most important social, economic and environmental challenges today. Forests are basic elements of the carbon global cycle and play an essential role as emission sources and as sinks.

At global level the deforestation and the forest degradation, through anthropogenic activities such as expansion of agricultural land, infrastructure development, devastated loggings and forest fires consist the 18% approximately of the greenhouse gases annually.

The forestry practices and specifically the afforestation and reforestation as well as the sustainable forest management contribute to the mitigation of climate change.

From the administration point of view, referring to forest and climate change in Greece we consider three issues: the mitigation of the anthropogenic climate change, the adaptation to the new climatic conditions and the commitments coming from the UNFCCC regarding the inventory of carbon from the LULUCF sector.

For the purpose of this meeting, a few elements of the existing situation of the forests in Greece, the way that forests impact to climate in general, the way that climate change will most likely impact to our forests, draft planning of national policy on the adaptation of forests and future steps that need to implemented will be approached.

State of forests in Greece

According to the latest national forest inventory (1992) the forest cover in Greece is:

- 3,359 εκ. ha (25,5%) of high forests
- 3,154 εκ. ha (23,9%) of other wooded land

while the total area of the state is 13,196 εκ. ha.

These ecosystems represent a vast majority of genetic resources and natural beauty having almost 6.000 species with more than 700 indigenous. The main forest species is the oak tree (22,60%) with the conifers to cover less area (*Pinus nigra* 4,33%, *Pinus halepensis* 8,72% and *Abies* spp. 8,34%).

Forests affect the climate

Forests can be either a carbon "sink" or a source of atmospheric carbon. Trees absorb carbon dioxide (CO_2) from the atmosphere during photosynthesis, emitting oxygen while using carbon to build woody stems, branches, roots, and leaves.

Trees, however, release CO_2 during respiration and after they die through decomposition or when they get burned or are logged. When carbon uptake in a forest exceeds respiration and other carbon losses, carbon "sequestration" occurs.

Young forests sequester carbon faster than old forests because CO_2 uptake greatly exceeds respiration, but old forests store more total carbon than young ones. In very old forests respiration may exceed uptake, and such forests have switched from being sinks to sources of atmospheric carbon.

Climate change affects the Greek forests

According to the two scenarios of climate change (B2 and A2), at the end of the 21st century the following changes are expected to happen:

- the precipitation is reduced 5% and 19% accordingly
- the air temperature is increased between approximately 3,0 ^{o}C and 4,5 ^{o}C
- the intensity of annual is increased by 10%

In other regions of the world with Mediterranean climate, such as California, the data until now have shown

- satisfactory or little increased rainfall but less snowfalls
- smaller duration of fusion of snow
- increase of mean of minimal temperature
- extreme meteorological phenomena (e.g. snowfall very late in spring)
- more drought in already dry lands.

Image 1. Forest under pressure. (Source: GBWC © GNHM, Life+ AdaptFor)

In Greece, data of systematic meteorological measurements in forest ecosystems that would present same tendencies have not been announced yet, however, foresters working in the field observe that rainfalls each year are satisfactory in the high productive forests but the snowfalls are less in number, with smaller duration and snow remains less days before its fusion.

Shortly the impacts to the Greek forests are expected to be:

- Enough rain but less snow => less underground water
- More frequent and severe forest fires, increase of forest fire season
- Loss of biodiversity: a shift to higher altitude and latitude of the south extent of forest species is expected
- Less snow in forest ecosystems => occasionally, more pests and diseases
- Drought in some areas
- Desertification and degradation

Initial planning of national forest adaptation policy
Taking into account the statement in the IPCC 4th Assessment report - Working Group II chapter of Ecosystems:
With regard to forests, the central problem is that any potential adaptation requires ***long-term planning****. Essentially, adaptation to climate would require planting trees today that will be suitable for such a future climate. However, given our uncertainties in the prediction of future climate and the formulation of models that are used to assess its ecological impacts, it is unlikely that adaptation measures will be put into practice in a timely manner,*
the General Directorate for the Development and Protection of Forests and Natural Environment, which is the competent authority for the policy on forest protection and management in Greece, in 2007, decided the first steps of approaching the issue of adaptation to be:

- To monitor the dieback and the health situation of the forests
- To enhance the enforcement of the sustainable forest management
- To adapt the forest management (aims, silvicultural methods etc.) to climate change
- To develop a small group of skillful personnel in the forest public sector targeted to several groups starting from school ages, for education on sustainable forest management and public awareness on the impacts of climate change and desertification (Forest Pedagogy).

For each step from the above mentioned, there was an initiative action mainly through some EU co-funding projects, such us LIFE+ FutMon, AdaptFor and INFORM.

Future steps
There are many things that still need to be done and the most important ones are:

- implementation of a Forest Adaptation Plan under the framework of a general approach on National Forest Policy or on National Adaptation Plan, which would provide the targets on adaptation actions of the next decade
- continuation of the dieback monitoring and the health situation of the forests
- budget allocation for forest inventory
- establishment of a network for measuring meteorological data on forests in high altitudes in all the country
- establishment of High Risk Zones for forest fires following the models of climate change at regional scale
- modification of the forest management plans guidelines in order to address the climate change impacts
- development of an evaluation system for the implementation of sustainable forest management
- development of a long-term forest education programme for public information and awareness

4.4.Assessment of Forest Fire Risks and Innovative Strategies for Fire Prevention

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At the 5th Ministerial Conference on the Protection of Forests in Europe (Warsaw, 5-7 November, 2007) the ministers responsible for forests in Europe committed themselves to ensuring that forests and sustainable forest management play an active role in sustainable development and for the general wellbeing of European society, endorsing as well a Ministerial Statement on forest fires, following catastrophic fires in several European countries.

As a pan-European follow-up to that Conference, FOREST EUROPE, together with its partners, decided to convene a workshop on forest fire prevention, under the focus area "Forests and Climate Change – Mitigation and Adaptation" of the FOREST EUROPE Work Programme, due to the expected role of climate change to wildfires.

The "Workshop on the Assessment of Forest Fire Risks and Innovative Strategies for Fire Prevention", was held on 4-6 May 2010 in Rhodes Island, Greece. It was co-organised by the Greek General Directorate of Development and Protection of Forests and Natural Environment, the Department of Forests of Republic of Cyprus, the Union of South European Foresters (USSE), the Ministerial Conference of the Protection of Forests in Europe (FOREST EUROPE), the Food and Agriculture Organization of the United Nations (FAO), the United Nations Economic Commission for Europe (UNECE) and the Silva Mediterranea Committee. The workshop was financially supported by the Hellenic Ministry of Environment , Energy and Climate Change and the USSE, while the European Commission (Directorate-general Environment and the Joint Research Centre) contributed indirectly by organizing its spring meeting of the group of experts on forest fires back-to-back with the workshop.

The objectives of the workshop were to review the current national forest fire prevention systems in European Countries, to identify innovative strategies, best available practices and possible policy instruments, and to develop policy conclusions and recommendations in relation to forest fire prevention in Europe. This was carried out with a view to building upon the existing knowledge and promoting the outcomes at a policy level.

The 73 participants were technical experts, forest policy advisors and policy makers, representing governments, NGOs and other stakeholders, from 19 countries. During the workshop it became obvious that forest fire prevention requires more attention. There is a great need to promote forest fire prevention policies and measures across the European region and an urgent need to place forest fire prevention on the policy agenda. To achieve this, vigorous and sustained actions at different levels are necessary.

At the first day, Session 1 was devoted to reviewing the current situation at international, EU and national levels. The first presenter displayed the main developments on forest fire prevention at international level, underlined the cost-efficiency when compared to suppression, the importance of having prevention plans and involving local communities. He noted the lack of complete, reliable and comparable information on forest fires at global level, even as basic statistics and the importance of raising political awareness and preparing, updating and implementing prevention plans. The second presentation was continued with a comprehensive review of the past and current EU activities and instruments dedicated to and relate to forest fires (Community Forest Action Programme, "Forest Fire" regulation, "Life+" regulation, EFFIS, etc.), and the recent initiatives taken on this issue by EU bodies, such as the "White Paper on adapting to climate change", the "Green Paper on forest protection and information", etc. In the final presentation of that Session, was given an overview of

existing forest fire prevention systems in some European countries, based on a questionnaire sent to national contacts in advance of the workshop, and the remarkable conclusions emerged from that initiative. Session 2 addressed causes of major fires and selected best practices/approaches to forest fire prevention. The first presentation was devoted to the causes of large forest fires in the Mediterranean region, and was followed by five successful bottom-up examples of fire prevention in different European regions. It should be noted that each session included a plenary discussion of identified gaps and lessons learnt.

On the second day, Session 3 was devoted to innovative strategies and policy instruments for forest fire prevention. It included six presentations on innovative strategies covering different aspects of prevention, and then the participants were divided into three working groups focusing on a specific topic, where they were asked to share views and highlight possible weaknesses and obstacles, with the aim of providing a series of actions and recommendations. The three topics were: "Forest fire prevention policy – How to make a difference", "Financing mechanisms and forest fire prevention" and "Integration of forest fire prevention in the international forest agenda". In the afternoon of the same day, a field trip was arranged to the area where the big fire of Rhodes took place in August 2008, and destroyed 13, ooo hectares. Participants had the opportunity to discuss in situ the causes of this fire, failure of fire prevention measures, the damages that resulted and the costs and strategies used in its suppression. A key lesson learned was that the final cost of four days of intensive fire suppression efforts, could have facilitated many decades of forest fire prevention of the entire island of Rhodes.

The third day included a plenary discussion about innovative strategies and possible new policy instruments on forest fire prevention. Finally, at Session 4 proposals and conclusions of the working groups were presented, participants discussed alternative strategies and possible new actions within a broader context, and a brief review of the workshop and the work that had been done was given. The final conclusions and recommendations were prepared with the active contribution of the workshop participants.

The final conclusions and recommendations of the workshop were divided into four categories. The first one concerns messages referring to the International and Pan-European level, the second to the European Union, while the third category contains conclusions and recommendations relevant to national level. The forth category contains suggestions and remarks with reference to financing mechanisms in relation to forest fire prevention.

Briefly, some of the conclusions and recommendations of the workshop are presented below:

International/Pan-European level

General messages:

- Forest fire prevention should be promoted as an integral part of sustainable forest management
- Current attention to the role of forests in climate change should be used to raise awareness about the risks of forest fires and the need for preventive measures

Proposed actions:

- Improve cooperation between different bodies/working groups
- Strengthen harmonized data collection and sharing of experiences across countries
- Fire prevention to be integrated in adaptation strategies
- A common understanding of forest fire prevention (definition, activities) is needed

European Union

General messages:

- Lack of data on economic efficiency on forest fire management (prevention, suppression and rehabilitation)
- Many initiatives and lack of coordination

Proposed actions:

- Disseminate and share experience
- Establish a sustainable and clear method of funding
- Build up and replicate the best practices of fire management
- Evaluate the effects and the efficiency of prevention

National level

General message:

- Encourage development of national forest fire prevention plans taking into consideration the particularities of the countries or the local conditions, the principles of sustainable forest management and future needs due to climate change

Proposed actions:

- Provision of future forest fire risk (climate change, social changes, etc.) for the purposes of defining sustainable prevention policies, action plans and budgets
- Promote the economic dimensions of forests in order to provide low cost prevention
- Encourage all countries to provide data on forest fires and forest fire prevention
- All education programmes should include raising awareness and education on forests and forestry

Recommendations concerning financing mechanisms

- Increased importance must be given to forest prevention measures, also on specific budget allocations, with the aim to reduce the probability of fire occurrence and to limit the effects of forest fires. Within these measures, significant weight should be given to fire preventive forest management measures and awareness raising campaigns
- Countries should encourage and promote the use of the existing financial recourses for implementation of fire prevention measures
- All EU member states should develop a comparable information system regarding forest fires investment distribution in order to develop a harmonized system such as the one at EFFIS
- The funding schemes should be attached to specific prevention plans and programmes

The whole report of the "Workshop on the Assessment of Forest Fire Risks and Innovative Strategies for Fire Prevention", can be ordered free of charge on the website www.foresteurope.org/Publications

4.5.Strategy for managing forest fires in the context of climate change

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Forest fires are a phenomenon documented from antiquity in Greece. It is closely tied with the Greek forests as well as with the forests of all other Mediterranean countries, as they form a basic element in the function of Mediterranean ecosystems. In the last few decades they have become a serious problem in Greece causing large burned forest areas, significant property destruction and even loss of life. Fire statistics show that the problem is getting worse with time in regard to their frequency, their characteristics and the damages they cause (Fig. 1).

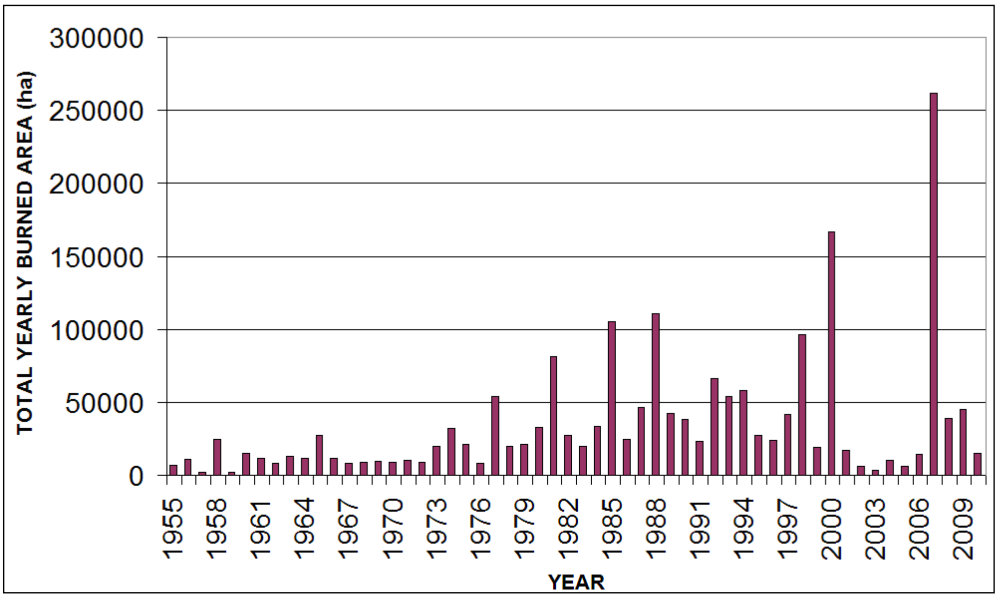

Fig. 1. Evolution of the total yearly burned area in Greece in the 1955-2010 period.

Developing a strategy to manage the forest fire problem, mitigating its consequences, requires an understanding of the reasons that made it become worse in the last few decades. An examination of literature both in Greece and internationally leads to the identification of the following major reasons (Sapountzaki et al. 2011, Xanthopoulos 2010):

- Failure of fire prevention. This failure ranges from failing to limit the number of new fire starts, especially under critical fire weather conditions, to failing to prepare for the case of serious fire in order to mitigate the destruction they cause.
- Weaknesses in the organization of firefighting. This has to do with firefighting effectiveness and efficiency and includes considerations about the organization, mutual cooperation and coordination of all the agencies and resources involved in fire suppression. Of special importance is the exclusion of the country's Forest Service from forest firefighting following the transfer of responsibility for this task to the Fire Service in 1998 (Xanthopoulos 2008).
- Biomass accumulation not only in regard to fuel load but also in regard to horizontal and vertical fuel continuity (Fig. 2). This is mainly the result of the abandonment of rural areas, of the turn of the people to energy sources other than wood for heating and cooking, and of a

steeply reduced biomass harvesting under scientifically guided forest management due to a weakened and underfunded Forest Service.

- Increase of the development of wildland-urban (WUI) (Fig. 3) and rural-urban (RUI) interface areas. The former is due to the exodus of people from the large city centers in an effort to live in better conditions, and to the development of vacation homes and tourist facilities next to forests. The second is due to the abandonment of traditional villages by the younger generation resulting in biomass under-usage and accumulation that reaches the houses (Xanthopoulos and Caballero 2007).
- Increased frequency of extreme fire weather conditions that, especially when combined with fuel accumulation, lead to fires that are very hard to fight. It is justifiably hypothesized that part of this worsening in fire behavior can be attributed to the climate changes that result in such weather conditions.
- Lack of integrated scientific knowledge in regard to forest fires especially at the policy making level.

The future

Predicting how the above sources of the problem may evolve is needed in order to develop a new strategy for forest management. As knowledge on forest fires gradually increases, it is likely that fire prevention will improve. On the other hand, the economic crisis experienced by Greece (and Europe) at the time of this writing, may represent a mixed bag. On one hand there may be societal conflicts leading to an increased number of fires, on the other hand many people may choose to return to their villages and re-start agricultural production. This may help reduce spatial fuel continuity. There are already signs of increased harvesting of wood for energy which, if done correctly, may help reduce fuels (fuel load, vertical fuel continuity). However, if left unregulated due to the weakness of the Forest Service, the results may be very negative for the condition of the forests and in regard to fuel build-up as people will opt to harvest large diameter timber leaving slash accumulations behind which represent a major fire hazard. The rate at which WUI areas appear and grow may also be affected negatively by the economic crisis. The situation in many RUIs is likely to improve due to the restart of agriculture and the use of biomass for heating.
In regard to climate, the changes predicted are likely to lead to higher temperatures and longer and more frequent drought periods (Giannakopoulos et al. 2010). This will result in higher frequency of difficult fires. Especially where there is significant fuel accumulation (e.g. where large *Pinus halepensis* forests have not burned for a long time) fire behavior may be extreme. Under such conditions firefighting is often impossible until conditions change and the protection of WUI and RUI areas is not assured (Fig. 4). The length of the fire season is also likely to increase. All these will represent increased challenges for the firefighters.

		
Fig. 2. Biomass accumulation	Fig. 3. WUI area in Stamata, Attica	Fig. 4. A destructive WUI fire in Penteli, Attica

Developing a new strategy for managing forest fires under climate change

A strategy that will try to mitigate the grim scenario presented above will have to address all the core issues that were identified. In regard to fire prevention it is necessary to form a group of knowledgeable and experienced scientists and operational experts from all involved organizations who will work on planning, executing and evaluating fire prevention actions on a continuous basis. They should have adequate funding. Emphasis should be given to education and involvement, under a cleverly designed framework, of all the population who should become aware of the increasing fire disaster potential. Prevention measures should be enforced very strictly especially on high fire danger days. Fire cause investigation must become a priority issue. Urban planning especially of WUI areas must be improved; cadastre development and definitive mapping of forest areas must be completed as soon as possible. The Forest Service must be supported organizationally, legally and financially and be obliged to re-instate active fire-aware forest management. Serious efforts should be made to secure acceptable income for the populations living and working in villages near the forests (forest workers, resin collectors, beekeepers, etc.). The population of villages and of WUI areas must learn and be prepared for the case of a fire impacting their settlement.

Great improvements are needed in fire suppression as the task will be more demanding in the future. Firefighter selection and training should be based on very high standards. Initial attack from the ground and from the air should be improved with better preparation of the ground forces and re-activation of the concept of helicrews that were successfully used in the 1990s (Xanthopoulos et al. 2010). The operation of the coordination center of the Fire Service should be improved making decisions as objective as possible utilizing modern technologies for data, modeling and decision support. Selection, positioning, dispatching and coordination of aerial means should be as effective as possible as they are a powerful tool, necessary for suppressing difficult fires but they are also extremely expensive. Specialized incident command teams will have to be organized and trained in order to improve firefighting coordination for large fires when this task becomes very complex. The importance of tools that can be utilized in indirect attack, when conditions do not allow direct assault on the fire front, such as use of bulldozers, backfire and burn-out, must be recognized. Proper training, establishment of criteria and operational protocols, and necessary legislature changes are needed in order to maximize benefits from their use.

Overall, the new strategy must be based on scientific knowledge on forest fires as much as possible in order to avoid pitfalls. It should recognize the ecological role of fire, the importance of fire prevention and the need to control forest fuel accumulation. Fire suppression should become both effective and efficient. The use of aerial firefighting resources which is very expensive should be reconsidered in order to achieve the best performance/price ratio. All relevant organizations should be asked to contribute according to their knowledge, personnel, equipment and specializations in order to succeed on managing the worsening fire problem under potentially serious budget cuts. Dependable fire danger prediction is the key to efficient organization as it can help save cost by mobilizing all involved organizations only when it is really needed. Finally, dependable fire statistics should be collected and analyzed in order to evaluate results and guide future improvements.

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4.6. Time variability of climate and forest fires in forest ecosystems og Greece

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Climate changes in Temperature and Water availability

Temperature variations can affect plant phenological behaviour and growth. The dates of growth initiation or the length of the growing period are defined mostly by minimum temperature. On the other hand, maximum and mean temperatures have a direct effect on water availability, affecting growth and development rates of rain fed ecosystems, especially during the water-stressed summer period.

The evapotranspiration-rainfall relationship can directly affect vegetation development. Monthly differences between reference evapotransporation (ETo) and effective rainfall (ERain) can be used to specify dry and wet periods in a region. Time variability of previous differences can also provide useful information for the climate change effect on vegetation development.

In the present paper, ERain – ETo and minimum (Tmin), maximum (Tmax) and mean (Tmean) temperature trends are studied. Data from 9 meteorological stations at altitudes 520-1310 m, covering the time period 1960-2006, are analyzed for temperature and water variability. The stations are located in agricultural and forest areas with no significant land use changes over the study period. Trends of temperature are calculated on a monthly, seasonal and on an annual basis, under different levels of confidence. The trends and their significance were examined by using the Mann-Kendal method (Mann 1945, Kendal 1975), whereas the slopes were calculated with Sen’s method (Sen 1968).

In general, significant yearly decreases of mean temperature are observed (Proutsos et al. 2011). Averaged for all sites, the annual mean temperature decrease rate is – 0.015 oC y-1. All months and seasons also present a negative average trend of mean temperature: November is the coolest month of the year and autumn shows the greatest temperature decrease. In comparison with mean temperature, an even greater decreasing rate is observed for minimum temperature. Monthly minimum temperature trends are similar to those of mean temperature. On a seasonal basis, however, spring’s minimum temperature shows maximum negative trend. On the contrary, maximum temperature slope has a positive annual trend, with a site-average of + 0.011 ^{o}C y^{-1}. The greatest increasing rate is observed in summer, July being the warmest month. In some months, even maximum temperature becomes cooler, November being the coolest. In conclusion, high altitude sites in Greece generally become cooler, even with respect to maximum temperature in some cases.

From the data analysis, a reduction of the available water in summer is generally observed. On an annual basis, water availability also depends on the altitude, showing positive trends towards higher altitudes, specifically:

- The relationship between available water increasing trends and altitude appears to be significant and linear.
- The forest ecosystems at relatively low altitudes (below 900 m), seem to face a more intense water deficit, compares to those located higher, where water surplus is observed.

- Water stress becomes more intensive in summer. However, better water conditions for vegetation development are observed in all other seasons, save for the altitudinal lower forest regions, where water availability appears to diminish, compared to previous years, during all seasons

Forest fires in Greece

The problem of forest fires, in all Southern EU countries, especially in Greece, is common and severe, due to climatic conditions, topographic anomalies and vegetation types, but also, in the case of Greece, to political and legal issues (Papastavrou 1995, Iliadis et al. 2002). The annual average number of forest fires in Greece is 985 (extracted from fire data of the time period 1955-2008), but with great variability from year to year (standard deviation 495), as shown in fig. 1 (Tsagari et al. 2011).

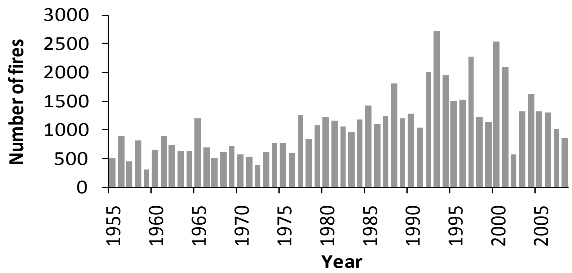

Figure 1 Annual number of forest fires in Greece 1955 - 2008

The annual burnt area in Greece also greatly varies from year to year (fig. 2). Every year wildfires burn, on average, 3,196±3,468 ha of forested and agricultural areas. However, the burnt areas, as well as the number of fires per year, have a statistically significant increasing trend for the time period 1955-2008, as detected by the Mann-Kendal test for trends identification (Mann 1945, Kendal 1975).

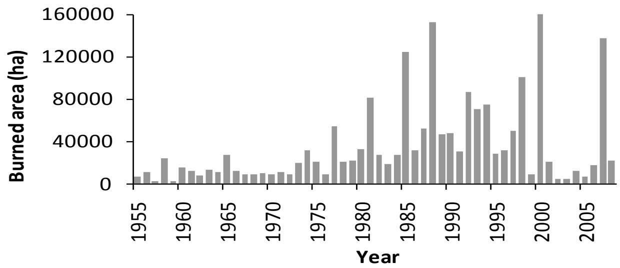

Figure 2 Annual burnt areas by wildfires in Greece 1955 – 2008.

The average size of forest fires in Greece, for the time period 1955-2008, is 28 ha per fire event, rising to 35.1 for the period 1983-2006 (where analytical data are available), with a standard deviation of 284.0 ha, derived from 30,465 values. The annual mean size of fires varies greatly (fig. 3) and shows even greater variations in different prefectures. However, the country's average magnitude of fires is much greater compared to other countries even in Southern Europe (Iliadis et al. 2002),, for example Spain (28.5 ha), Italy (19.7 ha) or Portugal (15.3 ha).

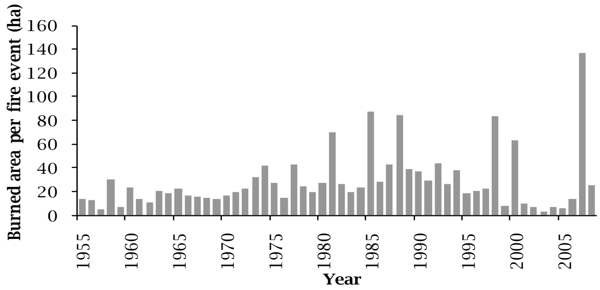

Figure 8 Annual average size of fires in Greece 1955 - 2008

Meteorological and climatic conditions are the main and most variable factors affecting the ignition and spread of wildfires (Pyne et al. 1996, Kunkel 2001). Daily relative humidity, temperature and wind speed, determine the final magnitude of the burnt area for each fire incident, increasing as humidity decreases and temperature and wind speed increase. Temperature, humidity and windspeed values are greatly affected by the altitude, land use and the latitudinal and longitudinal position of a region. These parameters can be considered as a mirror of the suburban environment, and contain significant information for a region, but are quite variable, even on a diurnal scale, affecting the risk for forest fires.

Conclusions

The general conclusion of this study is summarized as follows:

- On an annual basis, the average and minimum temperatures decrease and the maximum increase, thus leading to a less mild climate. On a seasonal basis, the average and minimum temperatures have decreased during all seasons at most sites, but maximum temperatures remain rather constant, with the exception of summer, when they increase. On a monthly basis, the most decreasing rates of temperature were recorded in November.
- The average temperature Sen-slopes were correlated with altitude, diminishing as altitude increases and showing that the climate has become cooler, compared to 50 years ago, at higher sites. The lower sites generally became warmer.
- A statistically significant increase of water stress at lower altitudes is recorded, but on higher altitudes the water availability conditions for vegetation development have improved at present, compares to those in the past.
- The number of forest fires, burnt areas and annual mean size have increased compared to those in the past, taking into account the great special variability of Greece. Forest fire parameters are greatly affected by many factors beyond climate (i.e. forest management, effectiveness of Forest and Fire Services, financial problems, etc), thus increasing the need for adopting policies for forest protection.
- For the evaluation of the impacts of climate cha
- nges on forest ecosystems, a continuous recording of fire and meteorological data needs to be established in the future.

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4.7.The contribution of WWF Greece in the protection of forest ecosystems, towards their "smooth" adaptation to climate change.

Dr. Nicholas Georgiadis, Scientific collaborator, WWF Greece

Introduction.

WWF is a global ENGO with fifty years of activity. In Greece, WWF operates permanently since 1991 when WWF Greece National Office was founded. One of the most intense actions of the organization in recent years is the effort to combat climate change. In this context, WWF Greece has launched a relevant campaign in order to inform the society, to exercise pressure on the state, to implement relevant educational programs, to achieve strong alliances and partnerships with other agencies and to carry out conservation actions in specific fields related to climate change. One of the most important elements which WWF Greece highlights in relation to climate change is forests. Forests affect climate and are affected by it. In years to come, it is certain that our forests will be affected by climate change, both in structure and in the forest species' territories. Drought, insects, species' translocation, will be some of the elements that climate change will brought to the ecosystems and the main threat in the Mediterranean region caused by these, will be uncontrollable forest fires. The above scenario is already familiar to Greece during the last few years. The truth is that forests can adapt to new climatic conditions alone, however, what we must do is to help them to adapt as smoothly as possible for their benefit, and thus for the benefit of people and of our planet. Taking this (among others) into account, WWF Greece has launched an ambitious project in 2007 entitled: "Forests for the Future" which includes several fields and political activities. A large part of this project deals with the problematic areas of prevention and suppression of forest fires as well as with forests' rehabilitation.

Summary of the "Forest for the Future" program's activities related to forest fires.

The following consist a brief reference to WWF Greece's main scientific field activities on forest fires related to the "Forest for the Future" program.

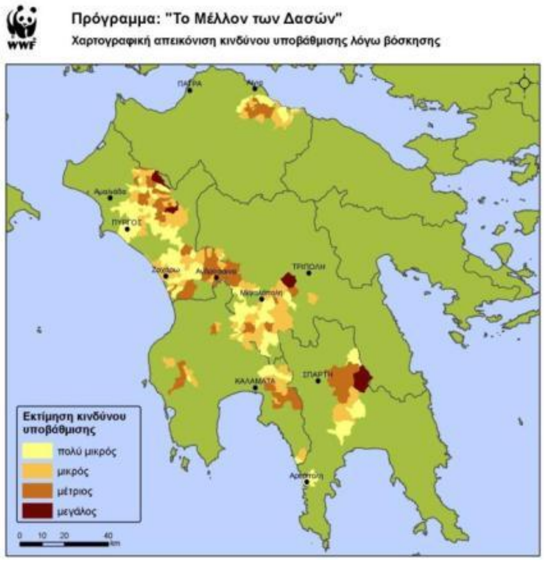
- *Rapid assessment of important forest fires*

Part of our efforts is channeled to the monitoring of forest fires, the assessment of their impacts and the formulation of relevant management proposals. Although all of the incidents during the fire-seasons are monitored, and a number of relevant field visits were conducted, a need for in depth analysis of impacts is emerging only for some cases, in which a relevant technical report, accompanied by maps and management proposals, are prepared for each one of them. Management proposals are submitted to authorities, and have indeed been adopted in some cases.

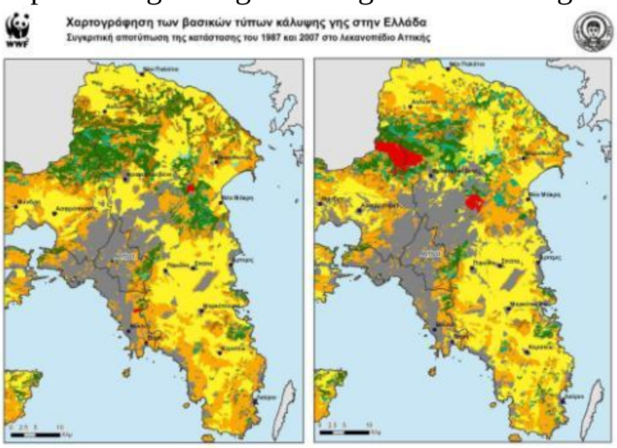
- *Overall monitoring of burned sites in the Peloponnese and land use changes in Greece.*

The monitoring activity of the burned sites of Peloponnese, which took place from the fires of 2007, has been a major issue of our program. More than 200.000 ha were burned in this area during the fire in 2007. Road transects throughout the burned areas were carried out and a large number of ecological and social parameters affected by the fire were recorded. The work regarded 235 fire-afflicted municipal departments and required 45 days of fieldwork and a similar period for data processing. The result was the creation of a database that contains critical information about the post-fire condition of the burned sites of Peloponnese, which was communicated to decision-makers and stakeholders and will also used to support other forest protection and advocacy activities. Generally, the post-fire resilience of the natural environment in Peloponnesus is satisfactory, with few problematic cases highlighted. Grazing pressures are important in some of the burned sites (Map 1),

and moderate (yet important) land-use change pressures exist. The latter, mainly refer to agricultural land expansion at the fringes of existing holdings. A large number of such cases (close to 100) have been documented through our work and submitted to authorities. Monitoring of land use changes expanded to all over Greece with the cooperation of Aristotelian University of Thessaloniki, using satellite images for the period 1987-2007 (Map 2). The above research shows us that, in general, forests in Greece were significantly reduced, in favor of other types of coverage (with dominant the agricultural areas) (Chart 1).



Map 1. Categorizing risks degradation from grazing.



Map 2. Example of Land use changes during the period 1987-2007 in Attica region.

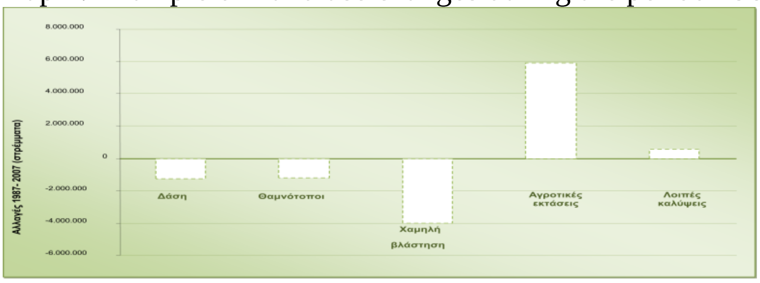
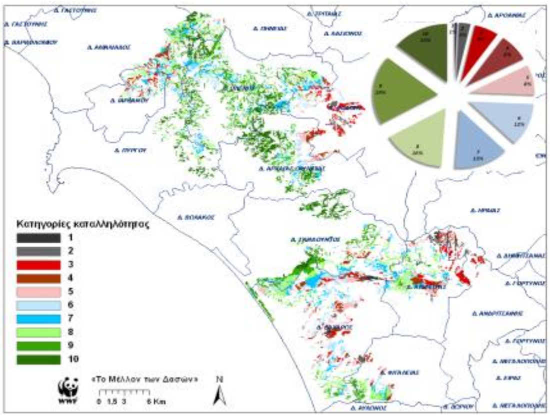


Chart 1. Greece's land use changes during the period 1987-2007.

- *GIS based prediction model of natural forest regeneration in Ilia*

After the catastrophic fires in southern Greece (2007), an effective post-fire rehabilitation strategy was set as a priority. An ideal case-study considered to be Ilia's prefecture, since the area reflects 30% of the total burned area of south Greece, making the sample quite robust. Ilia is an agro-forestry mosaic combining *Pinus halepensis* forests, cultivations and pastures. Our aim through this work was to locate problematic burned areas in terms of low or moderate resilience, try to explain the factors that may be responsible for this phenomenon and finally provide to the forest service a useful tool that could be used either for conservation purposes or for targeted reforestation actions (Map 3).



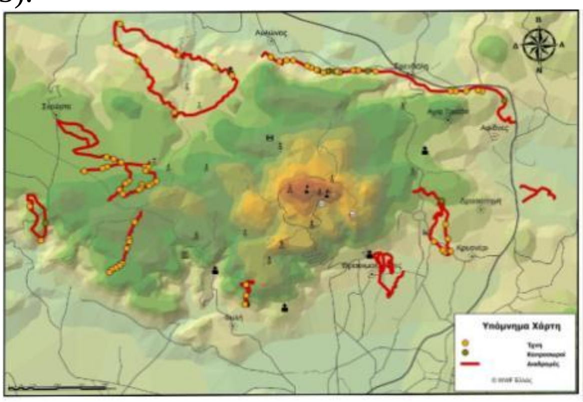
Map 3. Combined forecasting model of regeneration in the area of Ilia (Peloponnese).

- *Monitoring of unburned forest patches*

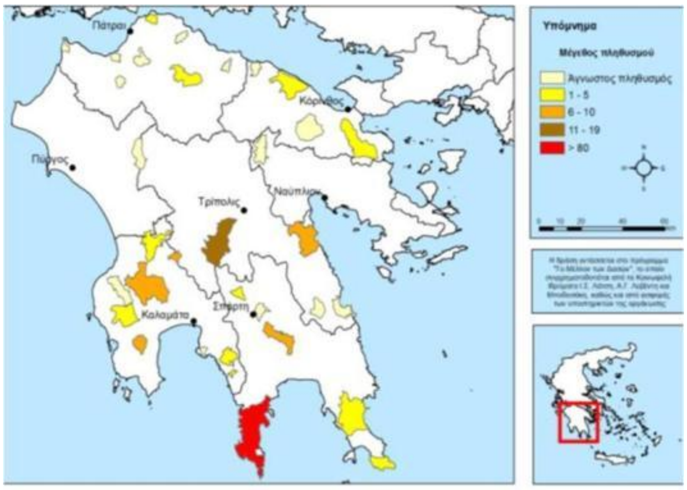
The specific monitoring activities regarding unburned forest patches, processes of re-vegetation and the re-establishment of micro-fauna populations, was finalized during the autumn of 2011. Two research teams have been set-up for this activity, with the collaboration of the Schools of Biology of the Universities of Athens and Patras. These two teams have monitored and analysed specific ecological parameters relevant to the flora and fauna with the aim of establishing knowledge necessary to guide future management and conservation activities. The presentation of the final reports and recommendations is available through our web site.

- *Species project*

The population and expansion of the red deer and golden jackals, whose habitats have been affected more than any other species of mammals in our country by the recent fires, were studied (Maps 4 & 5).



Map 4. Expansion of red deer habitats in Mount Parnitha.



Map 5. Population of golden jackal in Peloponnese.

Instead of epilogue.

All the above is a small part of WWF Greece's program entitles as: "Forest for the Future". More detailed activities and results can be found in our web site: www.wwf.gr.

4.8. Sustainable hunting and biodiversity protection

Evangelos Chatzinikos
Hunting Federation of Sterea Hellas

Without doubt, the preservation of biodiversity is essential for both wild life and ecosystems, as further loss will be detrimental for hunting. Hunters constitute a well organized community that preserves and manages large areas of the European countryside and have a deep awareness of their responsibilities regarding sustainable hunting of game species and the protection of nature and wildlife. Hunters want to restore and ensure satisfactory conservation status of game species and their habitat, because in this way they ensure the continuation of their activity in perpetuity.
Hunters invest their efforts in the protection of biodiversity, the conservation of habitats and the protection of the countryside of Greece and Europe. Hunting functions as an incentive to conserve wildlife and also to maintain, manage and re-establish their biotopes. For instance, the maintenance of hedges on crops and the not gathered parts of crops are of great importance for the small game species. The preservation of lakes and wetlands is important for the waterfowl birds. The conservation of forests and mountainous areas provide the ideal environment for ungulates animals. This is the reason why FACE (Federation of Associations of Hunters of Europe) is fully committed to the Council of Europe for the European Charter for hunting and biodiversity and has undertaken the Initiative on sustainable hunting and the active promotion of Natura 2000 network to all the other users on behalf of the European Commission.
Greek hunting federations have accomplished significant steps towards a better management of the game species during the last decades. Hunting federations implement continuous recordings of the hunting exploitations and following up of the hunting populations through the program “Artemis”. Furthermore, through the program “Habitat Improvement”, they substantiate projects to improve habitats for wildlife. In addition, they have established the “Federal Hunting Guards”, who have exhibited a recognized work till now. The financial resources for these programs exceed 10.200.000 € annually and are paid exclusively by hunters themselves.
The continuous scientific monitoring of the populations of game species as well as the phenology of migration of waterfowl birds at a national level constitute a basic priority for hunting federations because they provide the sustainable management of game species. The use of climate data constitutes a basic tool for the study of game species populations and an understatement of variations. The use of the processed products CLIMRUN, by hunting federations at this point, is a valuable tool for the administrative work they carry out.

4.9.Simulations of climate change impacts on forest ecosystems dynamics

Nikolaos M Fyllas & Margarita Arianoutsou
Department of Ecology and Systematics, Faculty of Biology, University of Athens

This manuscript summarises the research priorities of the ecological modeling group of the Department of Ecology and Systematics, Faculty of Biology, University of Athens, and potential links to the CLIMRUN project.

During the last ten years, a suite of vegetation dynamics models (VGMs) tailored to the Greek forest sector have been developed (Mazzoleni et al. 2004, Fyllas et al. 2007, Fyllas & Troumbis 2009, Fyllas et al. 2010). A common approach found within these VGM is the use of the "forest gap dynamics" theory and the individual-based representation of forest dynamics. All three VGMs use plant functional groupings for the approximately 30 dominant species in Greece, to categorise their response to environmental drivers and disturbance. Special interest has been paid to the role of fire in regulating forest dynamics under current and climate change scenarios (Fyllas & Troumbis 2009). Currently there is an effort, under two research projects (FP7-FUME and GRTN-MEDIT), to better parameterise important modules of these VGM. In particular, under the FUME project, the response of tree regeneration following fires and extreme climatic events is explored using both field and lab based studies. Under the MEDIT project, important tree functional attributes, including photosynthetic and respiration rates will be measured and incorporated in both small (Fyllas et al. 2010) and large scale (Sitch et al. 2003) vegetation models. The ultimate objective of both projects is to explore the response of forests under climate change scenarios.

The above opens up new opportunities for collaboration with the CLIMRUN consortium. Downscaled climatic reconstructions and climate change scenarios data will be necessary for the implementation of our projects. This could lead to integrated models that better represent both atmospheric and biospheric processes and more accurately quantify vegetation responses and feedbacks to climatic changes.

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4.10. Forest Fires: Causes, Prevention, Landscape Rehabilitation

Educational Programme of Argyroupolis Centre for Environmental Education (ACEE) for pupils, teachers and adults.

Farangitakis George, Economist-Biologist
Katsigianni Afroditi, MEd Environmental Education
Sbarounis Themistoklis, MSc Ecology
Argyroupolis Centre for Environmental Education

Abstract

Argyroupolis Centre for Environmental Education (ACEE) is a public educational and life-long learning institution carrying out educational and training activities and aiming at the promotion of Education for Sustainable Development (ESD). Its services are addressed to students, teachers, parents and local communities and include the following aspects: provision of educational and training programmes, development and co-ordination of local, regional, national and international networks of schools, production of educational material, initiatives of cooperation of institutions from the local to the national and the international level.

The premises of ACEE include 18 functional rooms or halls (for seminars, classes, laboratories, library, computers etc.) that are offered by the Municipality of Ellinikon-Argyroupolis. It is located in an urban area in the south-eastern part of Athens between Mount Hemettus and the Saronic Gulf. The Centre is staffed by both primary and secondary education teachers with experience and highly qualified in the field of environmental education. One of the unique features of ACEE and other Environmental Education Centers in Greece is the close cooperation and co-function of teachers who form the pedagogical team. To successfully address its objectives ACEE has developed cooperation with several educational and scientific institutions such as the University of Athens and the Hellenic Centre for Marine Research, with NGOs, with local authorities and societies. ACEE was founded in 1995 and it has maintained an active role in supporting and promoting Environmental Education up to day. Since 1997 it is co-funded by the European Union along with the financial support of the Greek government. The work that is presented here is the outcome of joint efforts and contributions of several members of the pedagogical teams of ACEE throughout the years.

The wider region of Attica, where ACEE is located faces the problem of forest fires especially during the warm and dry summer months since the climate is typical Mediterranean. These forest fires have several consequences not only as regards the degradation of forest ecosystems (including the suburban forest ecosystems) but also the quality of life of the inhabitants of Attica. The mountains of Hemettus, Pendeli, Parnitha, Poikilon and Aigaleo that surround Attica have been suffering several forest fires throughout historical times due to natural but mostly (especially nowadays) due to man induced causes.

Since 1997, ACEE having considered the issue of forest fires as a major environmental issue with several environmental and socioeconomic effects, has developed the educational programme entitled: “Forest Fires: causes, prevention, landscape rehabilitation”. This programme was initially addressed to pupils of primary and secondary schools and later on it formed the core theme of a series of training programmes for teachers, as well as a thematic network of schools. In the framework of this network participating school teams are involved in the study of this topic through long term school projects (usually for 2 years). During the first years the network was addressed to schools from the region of Attica but later on the network was developed in the national level and schools from all parts of Greece could participate. In addition, there are certain partnerships which support our

network: as regards the scientific background of the subject there is a continuous collaboration with the Department of Ecology and Systematics, Faculty of Biology of the University of Athens. We also collaborate with the relative departments of governmental authorities such as the Ministry of Agriculture and the Fire Department as well as with the Local Authorities of the region. Finally there is collaboration with NGOs such as WWF Greece and the Pan-Hellenic Association of Educators for Environmental Education.

After the big forest fires of 2007 the programme has been completely reformed and updated and nowadays it is also addressed to adults through life-long learning activities. It is worth mentioning that there is an increased interest of both students and adults for this topic, especially during the school years that follow big forest fires in Attica such as those of 2007 and 2009.

The cognitive objectives of our programme include: the knowledge of the structure and the function of Mediterranean Type Ecosystems (MTE), the role of fire as an evolutionary factor of MTE as well as a disturbance and stress factor, the several causes of forest fires and their categorization, prevention measures, means of effective response and post-fire management measures aiming to the rehabilitation of the landscape.

The programme is structured in three parts and aims to the critical reconsideration of the ways that human interact with his environment focusing on the issue of forest fires. The concept of sustainability as a regulatory concept of the relation between human, society and nature runs through the theoretical background of the programme. One of the major learning objectives is the consideration of fire as a natural stress factor in MTE with major evolutionary significance, where at the same time - and especially nowadays - is perceived as a serious threat, especially because of its socio-economic consequences, when the phenomenon incurs repeatedly, extensively and with great intensity. This threat does not only affect the forest as an ecosystem, but it has also severe socioeconomic effects on the populations of the burnt areas.

A series of didactic constructive techniques are applied throughout the programme so that the objectives of the programme to be accomplished. These techniques include: case studies, problem solving, brainstorming, categorization, experiment, concept mapping, completion of questionnaires, checklists and activity sheets, outdoor learning activities, structured discussion. Most of these techniques are developed by participants working in small groups (usually 4 to 5) so that students benefit from a collaborative learning environment. The evaluation of the programme is carried out through the completion of checklists that includes both post-fire management measures and prevention measures that should be taken and implemented in all levels of responsibility: from the level of individual citizens to the level of local communities and to the central government.

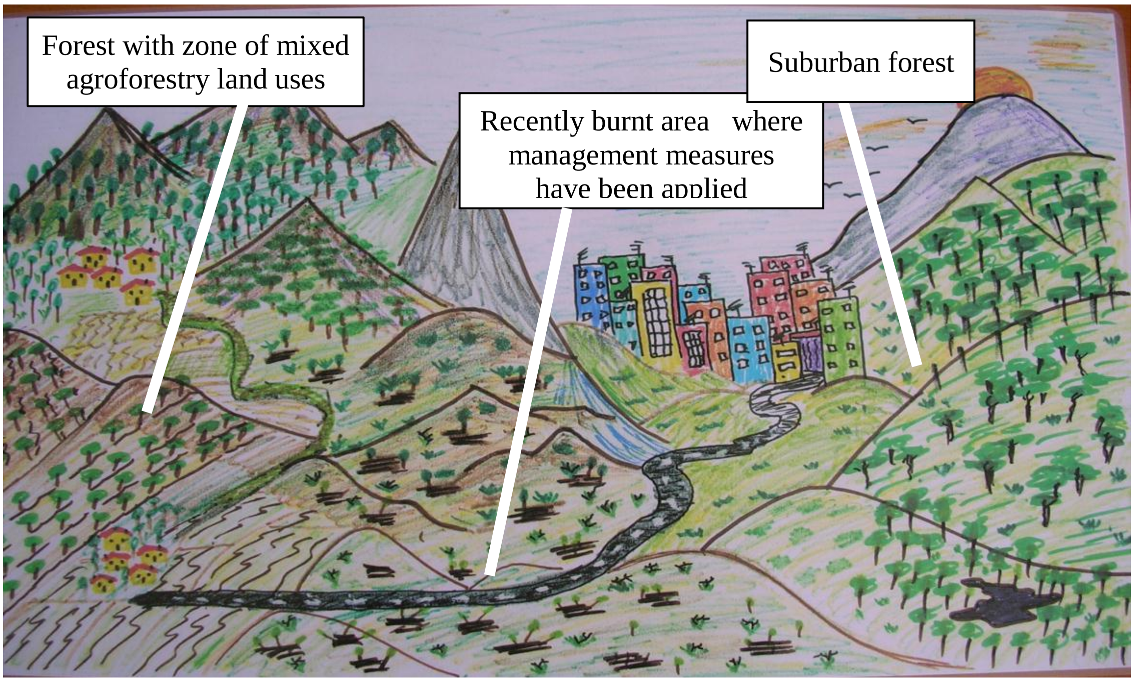

Figure 1: A1 sized drawing used as the back-bone of the programme where three different types of landscape can be distinguished (the explanations in the white boxes are not incorporated in the original drawing).

The design of the educational programme takes into consideration research findings regarding students' misconceptions and difficulties in the understanding of a series of concepts such as forest ecosystems, forest fires, erosion, desertification etc. Research has shown that thinking processes of pupils are based upon phenomenological features of certain concepts and when they have to deal with abstract concepts the cognitive processes for their understanding is based upon other concepts already known from their direct experience. The structure of the programme is based on two different case studies which are illustrated in a specially designed painted drawing (figure 1):

a) The first one (left in figure1) encompasses the kind of forest ecosystems encountered in the forest fires of western Peloponnesus in 2007. These forests represent a zone where a range of agro-forestry activities are applied; these activities include a series of land uses from agriculture (i.e. olive and grape cultivations) to apiculture and collection of resin.

b) The second one (right in figure1) encompasses forests on the mountains surrounding Attica such as Mount Hemettus that are repeatedly burned during the last decades.

There is also a third type of landscape (middle in figure 1) which links the two case studies and which represents a burned forest area (could be any of the two above-mentioned case studies) where post-fire management measures for control of the erosion have been applied.

In addition to the two case studies, the problem solving technique is used as a guiding strategy to structure the programme. The extensive forest fires of the summer of 2007 attest a major environmental problem with serious socioeconomic consequences along with their effects on the natural environment. In addition, as it can also be understood from the title of the programme there is an increased interest in the detection of the causes of forest fires, as well as the post-fire management measures aiming at the rehabilitation of the landscape. The main steps of the problem solving technique as it has been applied in the programme are: ascertainment of the problem, detection and recording of the causes and the conditions of forest fires, the consequences on the people as

individuals, communities and the socioeconomic effects, the effects on the natural environment and the response mechanisms of the latter, the proposition of adequate management measures in all stages of a forest fire: prevention, response and post-fire, action plan and evaluation.
The methodological approach of the programme has been extensively presented in the 4th Congress of the Pan-Hellenic Association of Educators for Environmental Education (P.A.E.E.E.).

The full reference is:

Farangitakis G., Bazigou A., Ioannou A., Nomicou Ch., Rempapi K., Sbarounis Th., Sotiropoulou D, Tragazikis P., Christodoulou N. (2008). *Methodological and conceptual analysis of the updated educational programme of Argyroupolis Centre for Environmental Education: "Forest fires - causes, prevention, landscape rehabilitation"*, 4th Pan-Hellenic Congress of P.A.E.E.E., Nafplion, 12-14/12/2008.

5. Summary

On September 28, 2011, in the framework of CLIMRUN project, the first workshop for the wild fires case study entitled "Effects of Climate Change on Forest Fires and Forest Ecosystems", took place at the premises of the National Observatory of Athens (NOA). The workshop, held in the Greek language, brought together 16 representatives from the public and private sector and from the academia, involved in the fields of forest fires and ecosystems. Their presentations covered a wide spectrum of interests with many inter-connected or overlapping fields of research and applications, which resulted in extensive discussions during the course of the workshop.
During the workshop, participants had the opportunity to fill in a perception questionnaire originally prepared for CLIMRUN, specifically adapted for the forest fires case studies. All participoants welcomed the provision of detailed data, tailored made for their applications through the use of climate services. Greater knowledge and understanding of climate variability and future projections was seen positively by the participants since it will provide them with the ability to understand and implement various models for their applications. Such applications include education, research or the public services responsible for Forest and Environmental Management

6. Annexes

6.1.Programme

1st STAKEHOLDERS WORKSHOP

EFFECTS OF CLIMATE CHANGE ON FOREST FIRES AND FOREST ECOSYSTEMS

28 September 2011, 10.00 am

Institute for Environmental Research and Sustainable Development

National Observatory of Athens

The National Observatory of Athens, in the framework of the EU project CLIMRUN (www.climrun.eu) will organize on September 28, 2011 a workshop on the Effects of Climate Change on forest fires and forest Ecosystems.
CLIMRUN attempts to develop a bottom-up protocol directly involving stakeholders early in the process with the aim of identifying well defined needs at regional and local scale.
The workshop will be held in the seminar room "AIMILIOS HARLAFTIS" at the premises of the National Observatory of Athens, (I. Metaxa and V. Pavlou, P.Penteli, Athens) in the Greek language.
The conference will bring together academics and representatives from the public and private sector who are involved in the fields of forest fires and ecosystems. Your participation will boost constructive dialogue between scientists and stakeholders allowing scientists to better understand stakeholders' needs and data requirements.

Arrival – Registration	10:00-10:20
Dr. Christos Giannakopoulos, National Observatory of Athens *CLIMRUN European Program*	10:20-10:30
Dr. Christos Giannakopoulos, National Observatory of Athens *Climate change in Greek territory*	10:30-10:45
Anna Karali, Anargyros Roussos, National Observatory of Athens *Evaluation of the Canadian Fire Danger Index and future projections of Fire Risk*	10:45-11:00
Irene Nikolaou, ETB / Ministry of Environment, Energy and Climate Change *The challenge of forest adaptation to climate change*	11:00-11:15
Iordanis Tzamtzis, Forester - Environmental Scientist *Estimation of Forest Fire Risk and innovative prevention policies.*	11:15-11:30
Dr. Gavriil Xanthopoulos, Institute of Mediterranean Forest Ecosystems and Forest Products Technology, NAGREF *Forest fire encounter strategies in the climate change framework*	11:30-11:45
Dr. Konstantina Tsaggari, Dr. George Karetsos, Dr. Nikos Proutsos, Institute of Mediterranean Forest Ecosystems and Forest Products Technology, NAGREF *Longitudinal changes in Forest fires and climate on forest ecosystems in Greece*	11:45-12:00
Coffee Break – Questionnaires	12:00 – 12:45
Nicholas Georgiades, WWF Hellas *The contribution of WWF Hellas in protection of Forest Ecosystems*	12:45-13:00
George Machairas, Forest Service of Piraeus *Prevention – Repression – Rehabilitation of Forest Fires* *Five Year experience in Attica Regions*	13:00-13:15
Evangelos Chatzinikos, Greek Hunting Confederation *Sustainable hunting and biodiversity protection*	13:15-13:30
Dr. Nikolaos Fyllas, University of Athens , Faculty of Biology Dept of Ecology & Systematics *Simulations of climate change impacts on forest ecosystems dynamics*	13:30-13:45
Themistoklis Sbarounis, Aphrodite Katsigianni, Environmental Training Center of Argyroupolis *Forest Fires: Causes, Prevention, Rehabilitation*	13:45-14:00

6.2.Questionnaire

Climate Change and Forest Fires

CLIM-RUN Project – WP6 wild fires
This work package (WP) focuses on the analysis of the climate information required in areas where forest fires represent a major hazard. The work will evaluate future fire risk in the Mediterranean and in specific target regions (mainly Greece) for the coming 10 to 50 years. The WP will illustrate how climate information can play an important role in the identification of vulnerable regions and in the management of existing and new forests. The work will focus on the relationship between heat waves, drought, water scarcity and fire risk.

A) General data:

Name: __

Job Title: __

Company/organisation: __

Type: Private company / Research Institute / Public service / Academic / Trade Association / NGO / Other
Level of Operation: International / National / Regional / Local / Other (specify)
B) Use/Requirements of Climate Information:

1. Does climate variability (and extreme weather events) have an influence on your sector's business activities?

- Yes
- No

2. What is your organisations perception of the risk(s) to your activity from climate variability in the mid-term (i.e., next 1-50 years)?

Most important / Very important / Important / Of secondary importance / Not important

3. What are the environmental problems/issues of <u>greatest</u> concern in relation to your sector (please tick all that apply):

Coastal/river flooding	
Drought	
Storms (snow, ice, sand, wind etc)	
Heatwaves	
Coastal erosion	
Salinisation	
Desertification	
Atmospheric pollution	
Water quality	
Loss of biodiversity	
Soil erosion	
Other (please specify)	

4. What kind of climate-related events and their impacts do you consider are important for your sector?

Please tick all that apply.

Extreme climate events (e.g., heavy rainfall, high temperature, heatwaves, low temperature, drought, flood, hail – please specify all that apply)	
Intra-season (within season) variability	
Inter-annual (year-to-year) variability	
Variations in the start / end / length of seasons	
Increasing / decreasing trends extending over a few years	
Increasing / decreasing trends extending over decades	
Other (please specify)	

5. What types of meteorological/climate information do you currently use in your activity? Tick all that apply.

None	
Daily weather forecasts (next 1-10 days)	

Severe weather forecasts and advisory notices	
Seasonal forecasts (next few months)	
Future climate projections (next decades or beyond)	
Historical observations (from weather stations, satellites, etc)	
Other (please specify)	

6. Does your institution currently have access to regional or national seasonal forecasts (i.e., for next few months)?

Yes/ No

7. Does your institution currently have access to local or regional climate change projections (i.e., for next decades or beyond?

Yes/ No

8. Which of your activities or services are affected by <u>current</u> variability in weather and climate and its impacts - and briefly, why/how?

____

____

____

____

9. Which of your activities or services are likely to be affected by <u>future</u> climate change and its impacts – and briefly, why/how?

____

____

____

____

10. Which of your activities or services could be improved with greater knowledge/understanding of climate variability and change – and briefly why/how?

____

____

____

____

11. Specification of climate data needs: please fill out the table to the extent that you are able at the current time by ticking one of the boxes (Essential, Desirable etc..) and indicating your confidence in the final column on each row.

	Essential	*Desirable*	*Nice to have*	*Don't know / Unsure*	*Confidence* [1]
Parameters/variables required:					
Temperature					
Rainfall					
Wind speed					

Wind direction					
Wind consistency					
Extreme events, e.g., heavy rainfall, frosts, heatwaves, very hot days/nights – please specify					
Other weather variables, e.g., radiation, sunshine, humidity, sea level pressure – please specify					
Weather-related indices and events, e.g., fire risk, dust storms, snow – please specify					

[1] Please indicate your level of confidence in answering these questions:

1: Confident

2: Not very confident - I would prefer to have more information (or consultation within my organisation) before giving a final response

3: Not at all confident – I need more information (or consultation within my organisation) before answering