Future vulnerability assessment of forest fire sector to climate change impacts in Cyprus

G. Lemesios, A. Karali, C. Papadaskalopoulou, S. Pitsari, D. Malamis, K. Ioannou, M. Zachariou-Dodou, C. Giannakopoulos, M. Petrakis, M. Loizidou

National Observatory of Athens
Institute for Environmental Research and Sustainable Development

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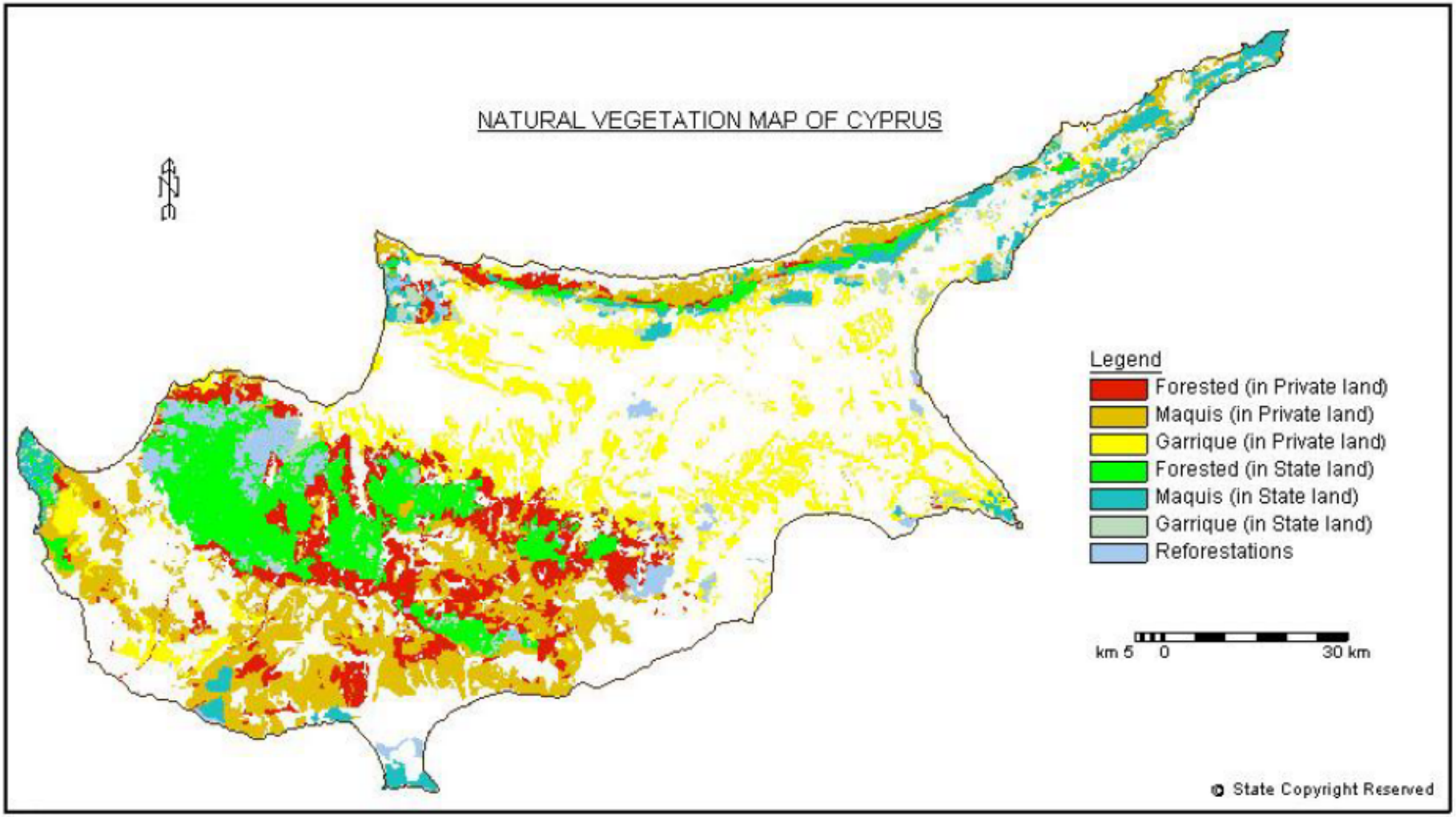
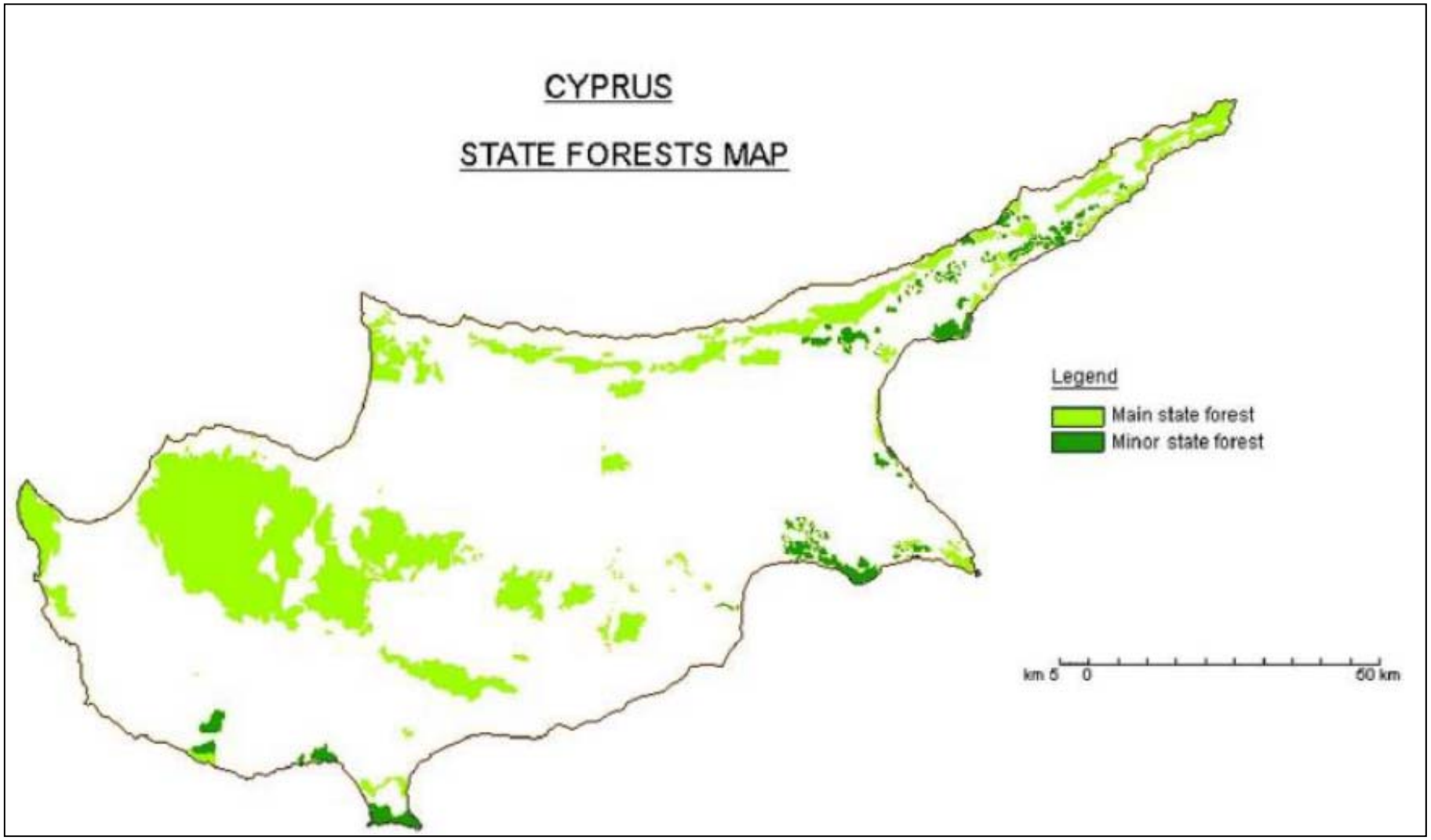
Introduction

- Two are the major classifications of the forest areas in Cyprus: a) forests and b) other wooded land, OWL (incl. maquis and garrique) which are either of state or private ownership.
- These categories account for 41,80% (386 718 ha) of the total land area



Introduction



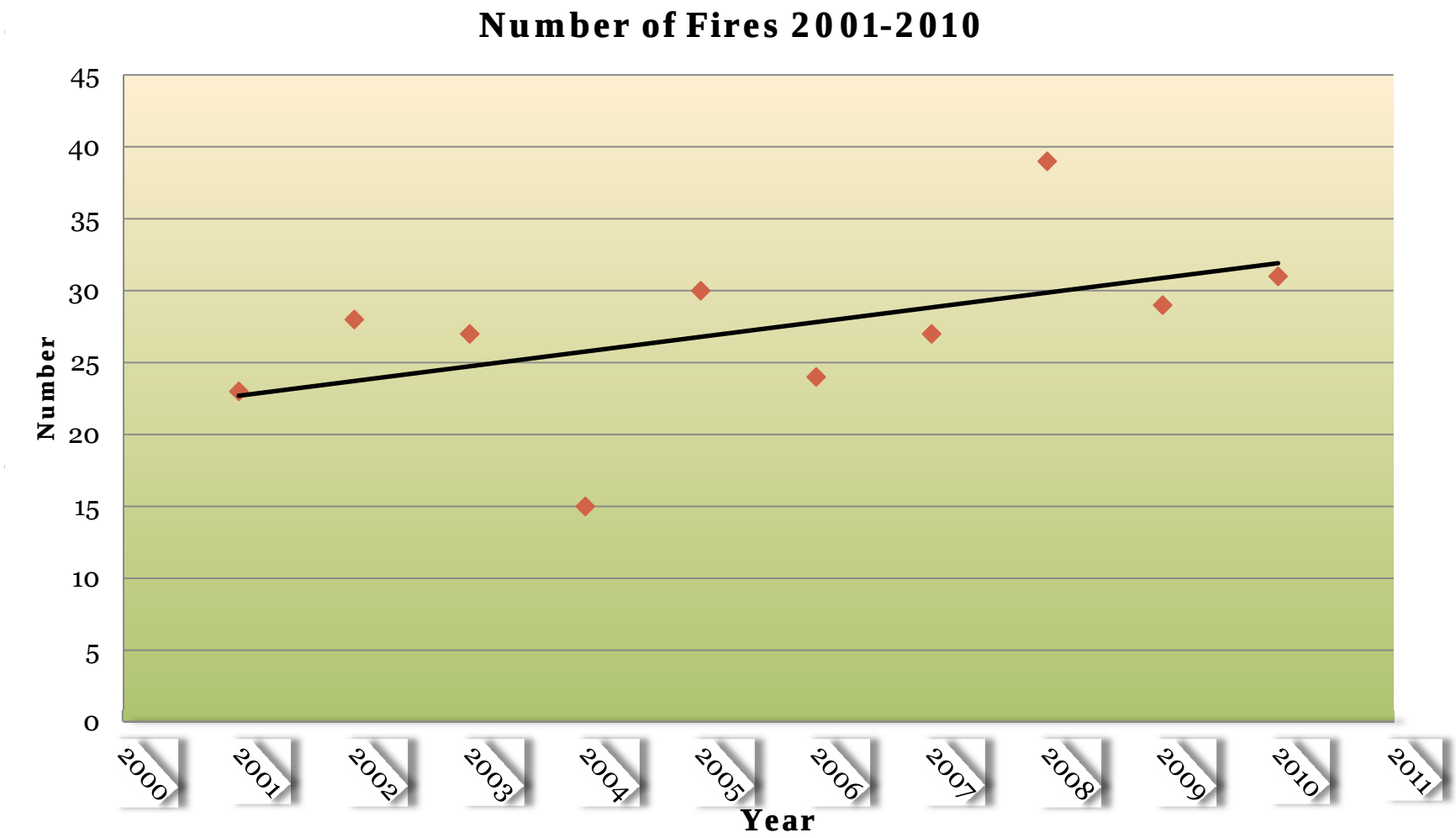
Introduction

- Forests of Cyprus are either natural (primary - undisturbed by man) or semi-natural. They are composed of a variety of natural vegetation including forests of conifers and broad-leaved trees such as pines, cedar, cypress and oaks.

- The dominant vegetation, up to 1400 m is Calabrian pine forest (*Pinus brutia*) which occurs in all forested areas of Cyprus. At higher elevation (1400 – 1950 m) the Black pine forest (*Pinus nigra* ssp. *pallasiana*) is dominant up to the highest peak.

- Other important species are the Cyprus cedar (*Cedrus brevifolia*), the juniper tree species of *Juniperus foetidissima*, and *Juniperus phoenicea*, the Mediterranean Cypress (*Cupressus sempervirens*), the Golden oak (*Quercus alnifolia*), the Syrian Maple (*Acer obtusifolium)* etc.

Cyprus forests and Fires

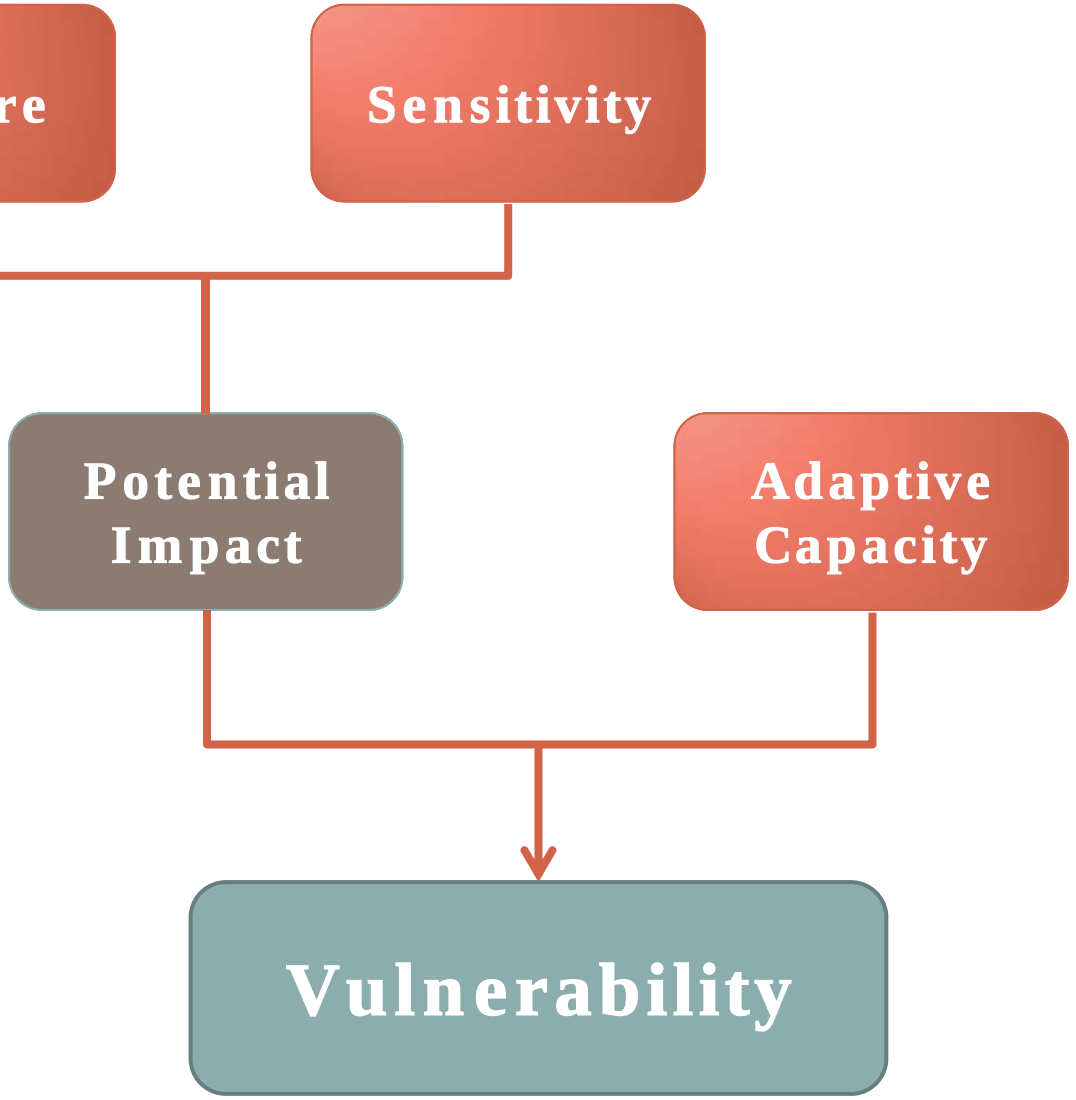


Source: Department of Forests

Vulnerability

"The degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity"

IPCC
3rd Assessment Report



Definitions

- *Exposure is the degree to which forests will be exposed to future climate changes and their impacts*

- *Sensitivity is the degree to which forests are or are likely to be affected by or responsive to climate changes*

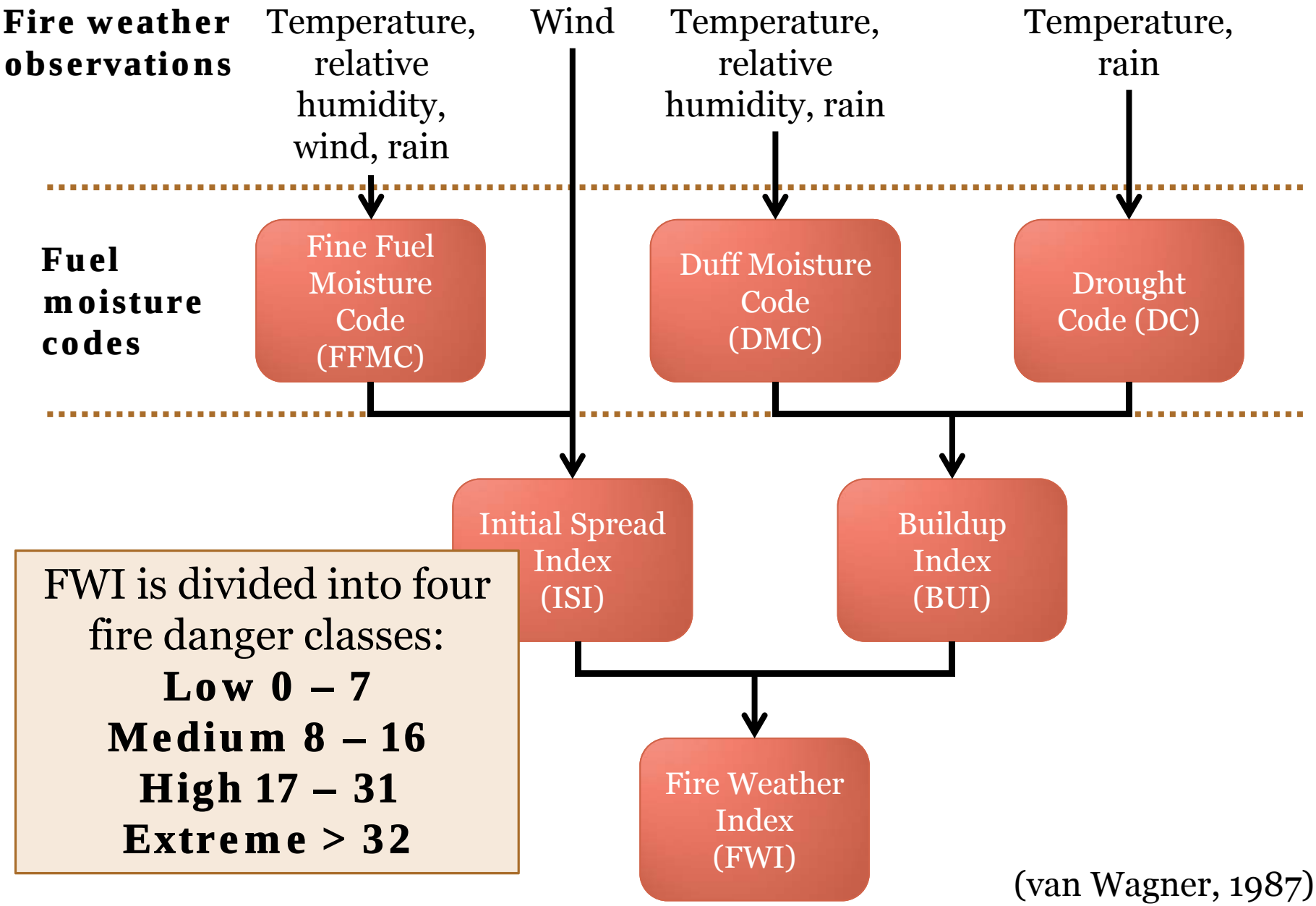
- *Adaptive Capacity is the ability of forests to adapt to the changing environmental conditions which is also enhanced by the measures implemented in Cyprus in order to mitigate the adverse impacts of climate change*

Assessment of Exposure

- Climatic indices :
  - Number of dry days (P<0,5 mm)
  - Max length of dry spell
  - Number of days with Tmax>35 °C
  - Average summer Tmax (°C)

- Meteorologically based Fire Weather Index (FWI)
  - Number of days with extreme fire risk (FWI>30)
  - Average Summer FWI

Canadian Fire Weather Index



FWI is divided into four fire danger classes:

Low 0 – 7

Medium 8 – 16

High 17 – 31

Extreme > 32

(van Wagner, 1987)

Regional Climate Modeling

- PRECIS (Providing Regional Climates for Impact Studies) - United Kingdom (UK) Meteorological Office Hadley Centre
- Horizontal resolution: 25km
- Control period: **1961 – 1990**
- Two future periods:
  - Near future - NF (**2021 – 2050**)
  - Distant future - DF (**2069 – 2098**)
- Future projections are based on A1B scenario (IPCC)

Climatic indices – Results I

Control Period

	Western Regions	Southern Regions	Southeastern Regions	Continental Lowland regions	Higher Elevation Regions
Nb of dry days (P<0.5mm)	200	250	280	280	265
Max length of dry spell (days)	15	60	90	85	70

Future Changes

		Western Regions	Southern Regions	Southeastern Regions	Continental Lowland regions	Higher Elevation Regions
Nb of dry days (P<0.5mm)	**NF**	+4	+4	+8	+8	**+11**
	DF	+12	+14	+15	+18	**+20**
Max length of dry spell (days)	**NF**	0	+7	+8	+10	**+13**
	DF	0	+8	+21	+22	**+9-15**

Climatic indices – Results II

Control Period

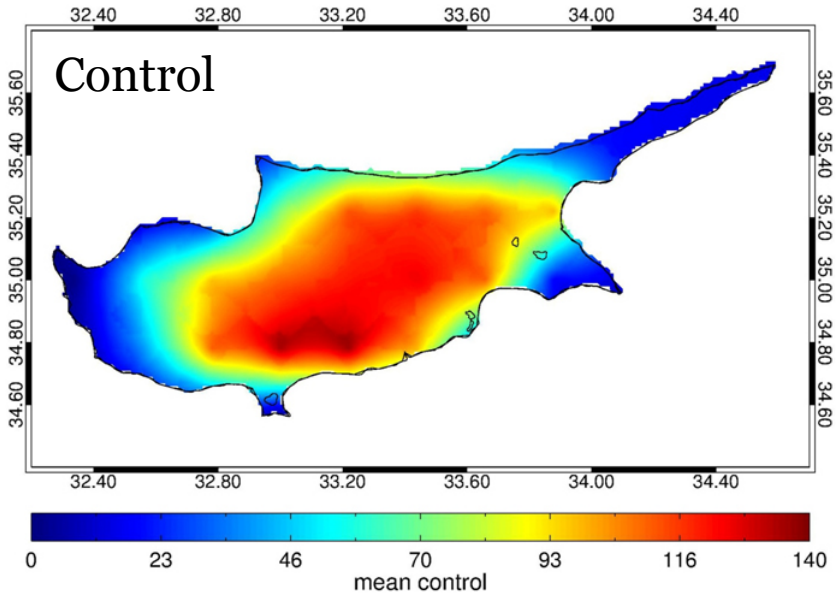
	Western Regions	Southern Regions	Southeastern Regions	Continental Lowland regions	Higher Elevation Regions
Nb of days with Tmax>35 °C	4	18	15	41	25
Average summer Tmax (°C)	27	30	30	34	33

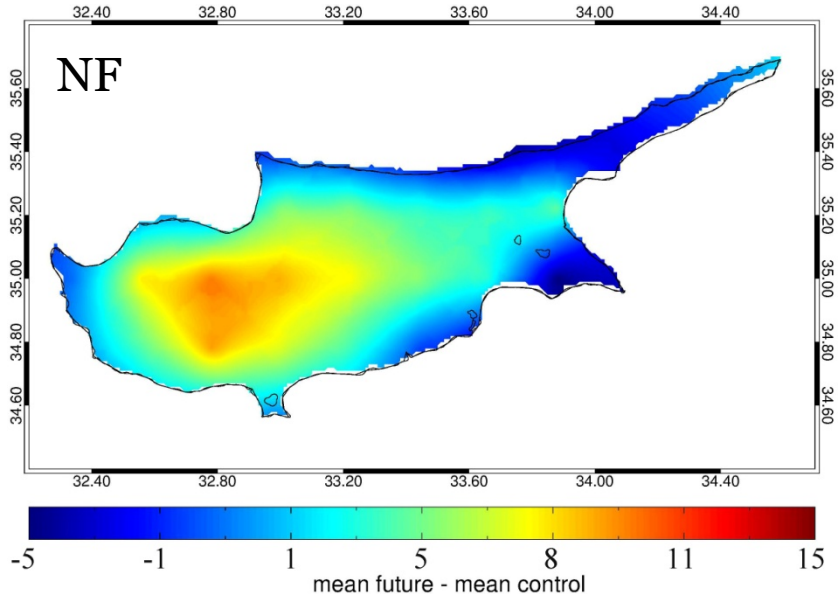
Future Changes

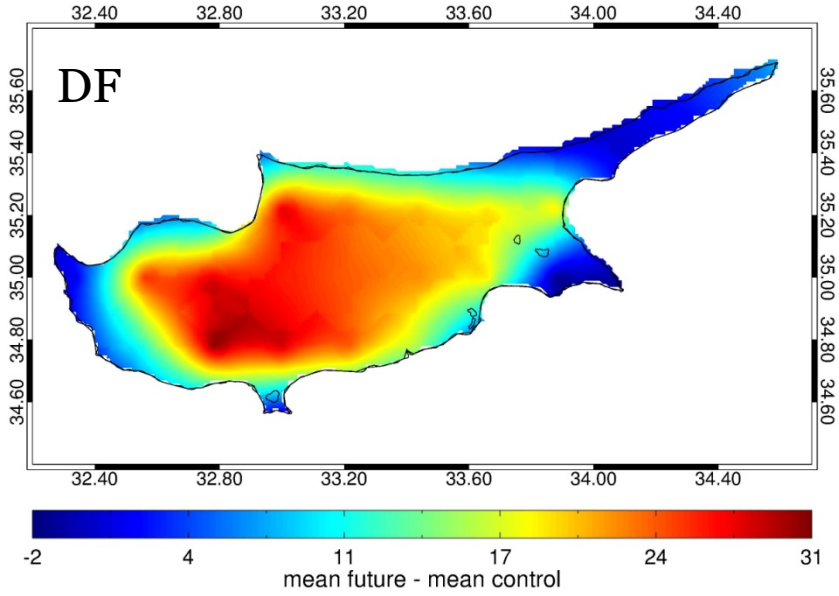
		Western Regions	Southern Regions	Southeastern Regions	Continental Lowland regions	Higher Elevation Regions
Nb of days with Tmax>35 °C	**NF**	+2	+19	+17	+34	**+30**
	DF	0	+32	+45	+55	**+52**
Average summer Tmax (°C)	**NF**	+1.6	+2.0	+1.8	+2.5	**+2.6**
	DF	+3.2	+3.8	+3.4	+4.8	**+4.6**

Fire Weather Index - Results

Number of days with extreme fire risk (FWI>30)



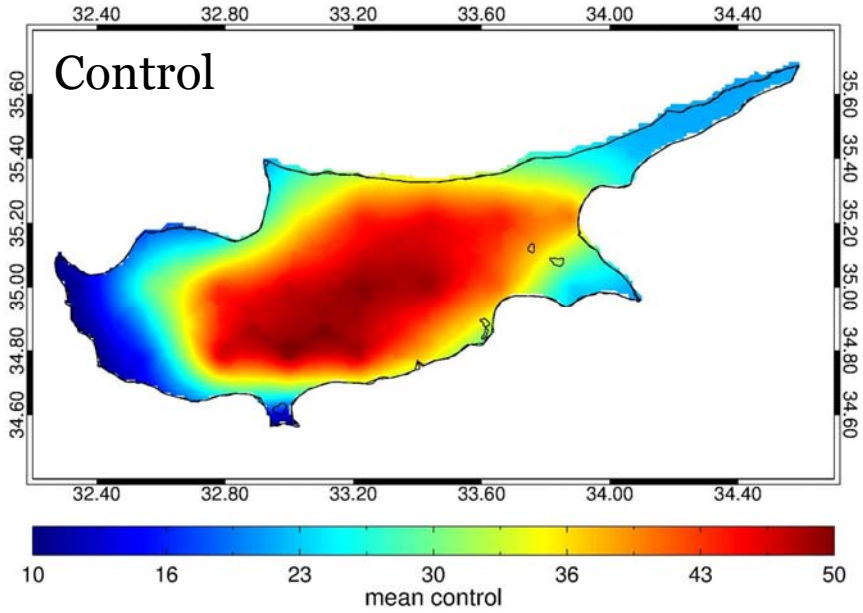


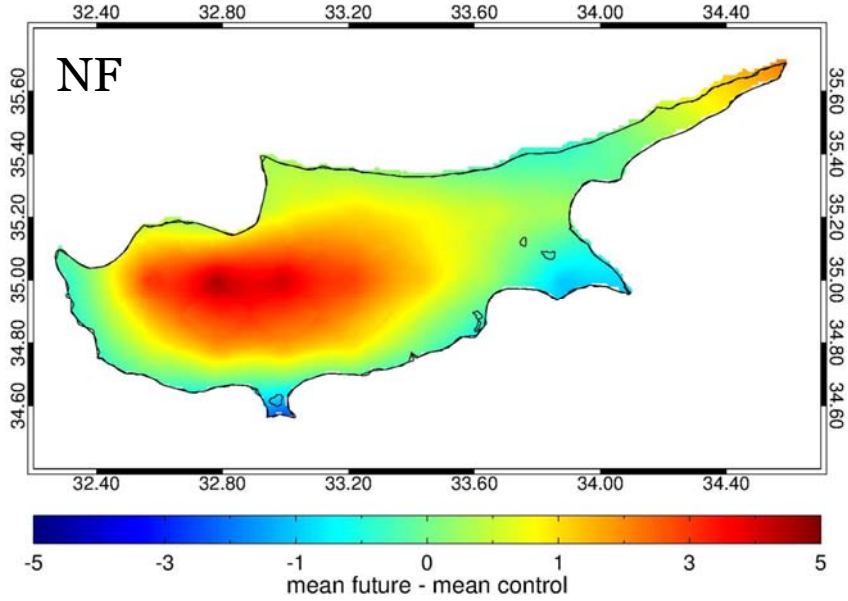


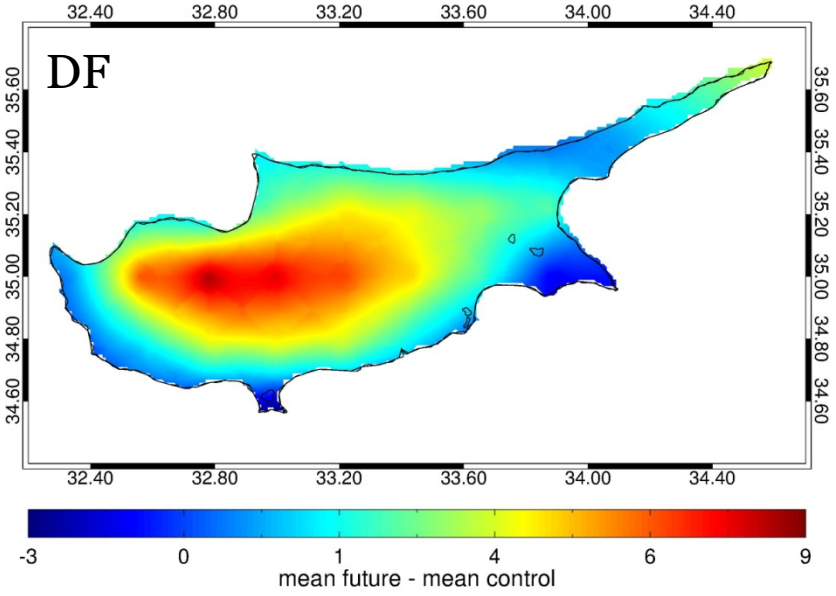
- Troodos Mountain shows the higher increase 8-10 days in NF and approximately 25 days in the DF.

Fire Weather Index - Results

Average Summer FWI







- Western areas present low fire risk
- The remaining forested regions present extreme fire risk during July
- In near and distant future the fire risk remains in the same high levels

Assessment of Exposure

- Taking into account the current exposure of forests to fires as well as the relative future climate changes the exposure of forests to fires for the future period (2021-2050) can be characterized as very high.

Assessment of Sensitivity

- Forests in Cyprus are sensitive to fires because of their composition which is dominated by flammable vegetation and the topography of the forested areas, which is mostly mountainous

- Moreover, urbanization increases the fire hazard because of the increase of flammable forest vegetation and decrease of human activity in the countryside as well as the availability of human and water resources in case of fires

Assessment of Sensitivity

The area, density and distribution of the main forest tree and shrub species that are threatened by forest fires as well as the range of threat within Cyprus

Species (scientific names)	Area (ha) of species, natural distribution	Average number of tree per hectare	Distribution in Cyprus	Threat Category*		
				High	Medium	Low
Cedrus brevifolia (tree)	367	75	Local		X	
Juniperus excels (tree)	643	32	Local		X	
Pinus nigra ssp. *pallasiana* (tree)	4,970	n.a.	Local		X	
Juniperus foetidissima (tree)	72.7	n.a.	Local		X	
Quercus infectoria ssp. *veneris* (tree)	354.7	n.a.	Widespread	X		
Cupressus sempervirens (tree)	450	n.a.	Widespread			X
Arbutus unedo (shrub)	1.5	53	Local	X		
Phillyrea latifolia (shrub)	596	8.4	Rare	X		
Viburnum tinus ssp. *tinus* (shrub)	17	60	Local	X		

** Threat categories: High – threatened throughout species range within Cyprus, Medium – threatened in at least 50% of range within country, Low-threatened in less than 50% of range within country.*

Department of Forests, 2011

Assessment of Sensitivity

- The long, hot and dry summers that last from May until October increase the fire risk since they convert the pine as well as shrubs into a dry and highly inflammable fuel mass. During the fire season the temperature fluctuates from 30°C to 44°C increasing the risk of ignition to very high levels.

- Considering the above, the sensitivity of Cyprus' forests to fires is characterized as **very high**.

Assessment of Adaptive Capacity

Several measures are taken by the Forestry Department of Cyprus aiming to eliminate forest fires.

- **(A) Fire Prevention measures**: Law enforcement – impose penalties for causing forest fires, Organizing of information campaigns, establishment of Picnic and camping sites, Fire danger mapping.

- **(B) Fire Pre-suppression measures:** Fire breaks, Forest roads, Forest telecommunications, Forest Stations, Silvicultural treatments, Detection and reporting of forest fires etc.

- **(C) Suppression measures**: Fire brigade, Stand-by of forest officers, Fire engines, Aerial means , Water tanks and hydrants etc.

Assessment of Adaptive Capacity

- In the framework of the Rural Development Programme 2007-2013 of Cyprus, economic incentives are provided to individuals through the Measure 2.5 *"Protection of forests from fires and reforestation areas"*.

- The main purpose of the measure is to improve the existing protection system of forests and other forest areas from fire as well as the restoration of burned areas. The measure includes the following two actions: (i) fire prevention, (ii) reforestation of burnt areas.

- This measure enhances the protection of private forests which are not covered by the national forest protection programme.

Assessment of Adaptive Capacity

- Despite the great efforts and the good results of recent years, the problem of fires still exists and will always constitute a permanent threat for the forests of Cyprus.

- The adaptive capacity of Cyprus forests to fires can be characterized as moderate

Assessment of overall vulnerability

Degree of sensitivity, exposure & adaptive capacity		Degree of vulnerability		Legend
None	0	None	V≤0	
Limited	1	Limited	0<V≤1	
Limited to Moderate	2	Limited to Moderate	1<V≤2	
Moderate	3	Moderate	2<V≤3	
Moderate to High	4	Moderate to High	3<V≤4	
High	5	High	4<V≤5	
High to Very High	6	High to Very High	5<V≤6	
Very high	7	Very high	6<V≤7	
Not evaluated	-	Not evaluated		

Vulnerability = Impacts – Adaptive capacity

Impacts = Square root of (Sensitivity x Exposure)

Overall future vulnerability of forested areas in fire risk

Impact	Sensitivity	Exposure	Adaptive Capacity	Vulnerability
Fires	Very high (7)	Very high (7)	Moderate (3)	Moderate to high (4)

Conclusions

- Drought and hot conditions that drastically increases flammability during summer period are expected to increase highly in the near and distant future in the forested areas of Cyprus
- The investigation of the FWI, revealed that Troodos Mountain and the majority of the forested areas present extreme fire risk both in near and distant future.
- The sensitivity of Cyprus forests to fires is highly increased because of their composition which is dominated by flammable vegetation and the topography of the forested areas, which is mostly mountainous
- The adaptive capacity of forests are greatly depend on the measures that are taken by the Forestry Department of Cyprus to eliminate forest fires but the problem of forest fire still exists and will always constitute a permanent threat for the forests of Cyprus

Thank you for your attention!

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