



Innovative approaches for fire-smart landscapes

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Valuation of forest land in Greece

- Methodology developed in 2014 by the Institute of Mediterranean & Forest Ecosystems in Athens following a request from the Forest Service.
- Highly needed.
- Prerequisite: Detailed field work should not be required
- It became a law immediately and is currently applied successfully across the country

$$[(V_w + V_{nwfp} + V_g + V_h + V_r + V_{ps} + V_{sq} + V_b) - (D_f + D_e)]$$

$$TEV = \frac{\text{-----}}{p}$$

Where:

TEV= Total Economic Value of Forest Land

V_w = Value of the annually produced timber

V_{nwfp} = Value of the annually produced Non-Woody Forest Products (NWFP)

V_g = Value of the annually produced grazing

V_h = Value of the annual use for hunting

V_r = Value of the annual use for forest recreation

V_{ps} = Value of the annual soil protection offered by the forest

V_{sq} = Value of the annual carbon sequestration

V_b = Annual value of biodiversity of the forest

D_f = Annual damage due to the probability of forest fire

D_e = Annual damage due to soil erosion

p = Discount rate (%)

All values expressed in monetary units (Euro)

Externalities: Forest fire damages

- The cost of forest fires (prevention, suppression, damages (destruction of wood and NWFP, loss of production potential for some time etc.), post-fire rehabilitation) can be quite significant.
- Currently, this cost (€/ha) is assessed based on a long-term estimate for the whole country, so this externality is not very “heavy”.
- However, if, in future refinement, we take into consideration the spatial non-homogeneity of this cost (differences between species, methods of management, fire danger distribution (e.g. North vs South, high elevation vs low elevation)), and the current and future trends, this cost is likely to become a major concern for certain forests.
- Even regarding insurance, distribution of this cost is an important concern (e.g. California).
- Independently of the approach of insurance companies, human life and other intangible values are at stake.

Forest fire risk

(Modern approach)

- Forest fire risk is determined as the combination of:
 - The probability of occurrence
 - The fire intensity
 - The potential damages
- The latter includes elements such as value, level of exposure, vulnerability and protection potential
- Buildings, agricultural enterprises, industries, etc. obviously have a higher value compared to the forest itself.
- Especially, regarding human life, “post-fire rehabilitation” is out of the question....., so protection of life is the first priority.

First conclusion

- In conclusion, we cannot ignore forest fires in our forest-based Bioeconomy analyses and development efforts.
- This is especially important in specific ecosystems, such as the Mediterranean ones, where fires play an important role.
- We need to understand forest fires, their role, and the threat they may represent, and we should be able to project and anticipate future developments, taking appropriate measures.

Understanding forest fires

- We need to understand the problem before trying to solve it.

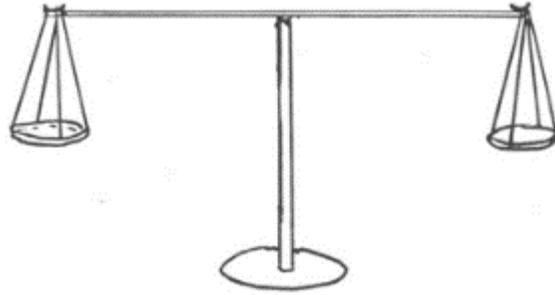
“The significant problems we have cannot be solved at the same level of thinking with which we created them.”

Albert Einstein

Forest fires: A natural phenomenon

- Forest fires are a natural phenomenon playing an essential role in the natural life cycle of most forest ecosystems around the world: Forest vegetation regenerates naturally, grows through photosynthesis, reaches maturity, gets old, dies, and needs to break down in order for the cycle to start from the beginning.
- The prevailing conditions regarding moisture and temperature influence the rate of the breakdown of dead biomass through insects, fungi, bacteria etc.
- If the breakdown rate is lower than the rate of biomass production, (i.e. it is not adequate and a biomass surplus is created), then nature has an alternative tool: **fire**.

Long-term balance of biomass



BIOMASS ACCUMULATION

Growth (adds live biomass)

Mortality (adds dead biomass)

- Age, natural competition
- Fire
- Insects
- Diseases
- Wind & Snow

BIOMASS DEPLETION

• **Natural gradual breakdown**

(slow oxidation – insects, worms, fungi, bacteria,...)

• **Fire** (rapid oxidation)

• **Physical biomass removal**

- Man (timber, wood for energy)
- Animal grazing (domestic & wild)

- The frequency, the intensity and the exact ecological role of fire are influenced by the rate at which biomass builds up.

Biomass reduction through fuel management projects



Forest fires: A serious problem

- Forest fires constitute a serious problem for Europe.
- Although there exists a sharp gradient from the South (i.e. Mediterranean) to the North, in terms of fire regime (e.g. contributing and causing factors, fire frequency and burned area, fire behavior), no country is exempt (Tedim et al, 2015).
- This has been demonstrated very clearly in the summer of 2018, with unexpected serious fires in Sweden, Germany, Great Britain and Ukraine, surprising both citizens and authorities.

2018



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Sweden now fighting 50 wildfires as EU nations rush water bombers

After Italy and Norway sent helicopters and planes, other neighbors have pledged help to douse dozens of forest fires across Sweden. Authorities have said some of the blazes are "impossible to extinguish."



© Reuters/TT News/M. Anderson

More than 50 wildfires – 10 more than the previous day – are now alight across central and western Sweden, but also above the Arctic Circle, authorities confirmed on Friday.



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Berlin-area firefighters beat back major forest fires

Three villages were evacuated in the northern German state of Brandenburg as 400 hectares of forest went up in flames outside Berlin. The fire ignited World War II and Soviet munitions dumped in the ground.



© picture-alliance/dpa/P. Pivul

BRANDBURG FOREST FIRES FORCE EVACUATION

Villages evacuated

The fires began on Thursday and soon threatened three villages in the state of

2018

[UK](#) [UK politics](#) [Education](#) [Media](#) [Society](#) [Law](#) [Scotland](#) [Wales](#) [Northern Ireland](#)

Manchester

Saddleworth Moor fire declared major incident as residents evacuated

Army on standby as huge blaze forces residents in Stalybridge to leave their homes

[Wildfires sweep across moors outside Manchester - in pictures](#)

Helen Pidd and Kevin Rawlinson

Wed 27 Jun 2018 08:34 BST

[f](#) [t](#) [e](#) 4,814

This article is over 3 months old



▲ Timelapse footage shows huge fire at Saddleworth Moor - video

Firefighters in [Greater Manchester](#) are continuing to battle a huge fire on

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Princess Eugenie wedding: celebrities and royal guests gather for ceremony



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Forest fire management: a complex issue

- In conclusion, forest fires are a natural phenomenon but they are also a significant natural hazard for modern societies.
- Their management is a very complex issue presenting many challenges because it must address and reconcile many environmental, technical, social, financial, legal and political considerations, and involves three different but interlinked phases:
 - Prevention,
 - Suppression and
 - Post-fire rehabilitation.

.... and now Global Change

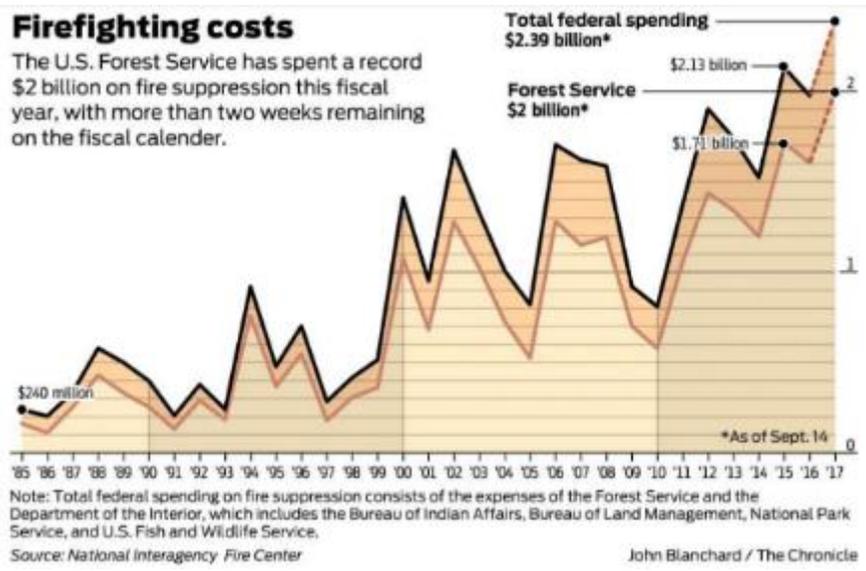
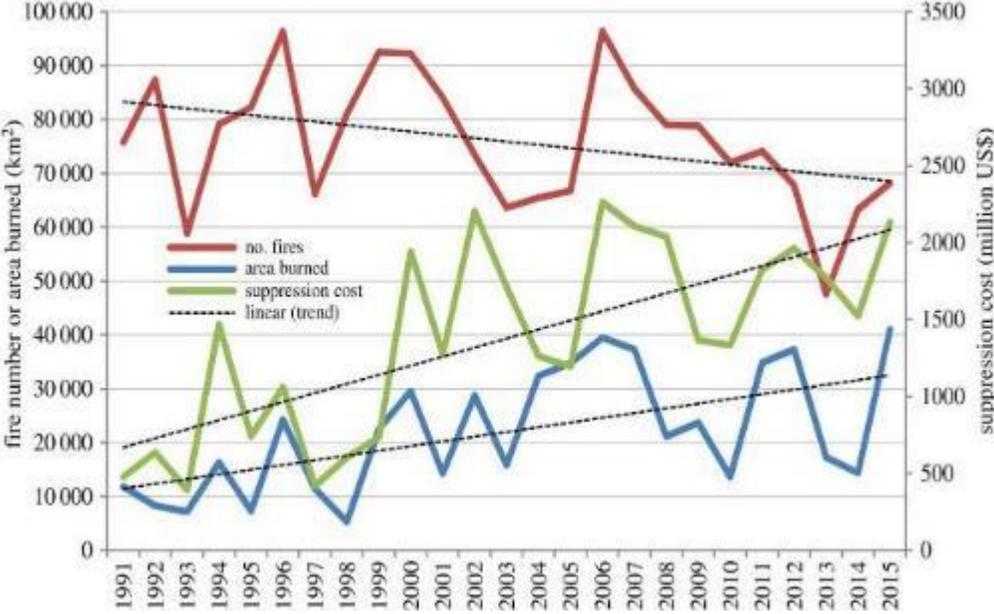
- This complexity is even higher nowadays because the dynamics of forest fires are evolving as a result of climatological, social and political changes, financial and legal constraints, etc., all of them being part of what is referred to as “Global Change” (GC).
- The effects of Global Change on the forest fire problem and the challenges to forest fire management, especially regarding Climate Change (CC), have been examined by many researchers around the world in the last two decades or so.
- Formulating what to do, however, is really a challenge

The shape of things to come
(current and future trends)

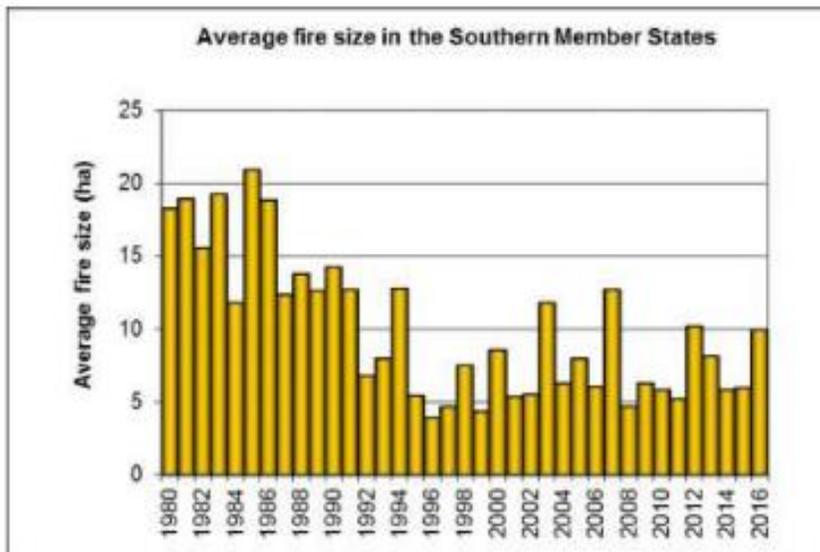
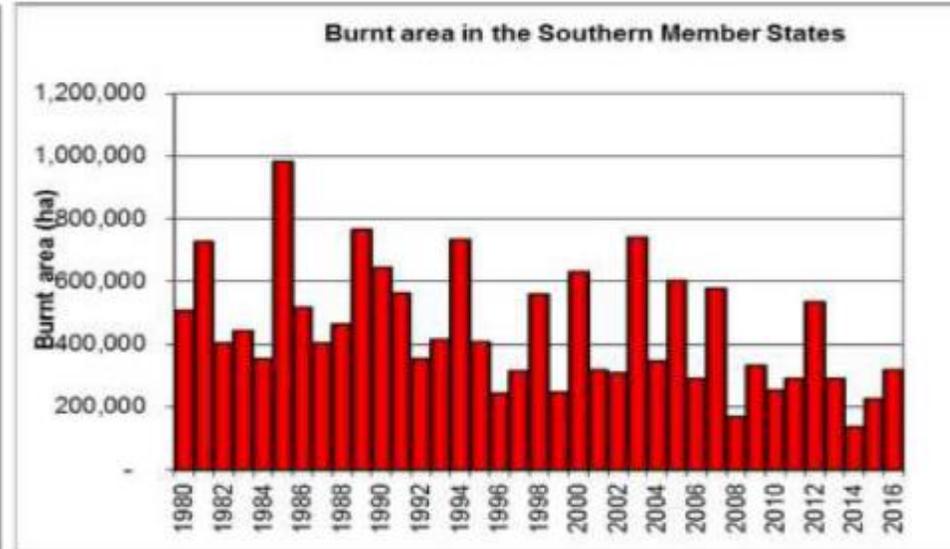
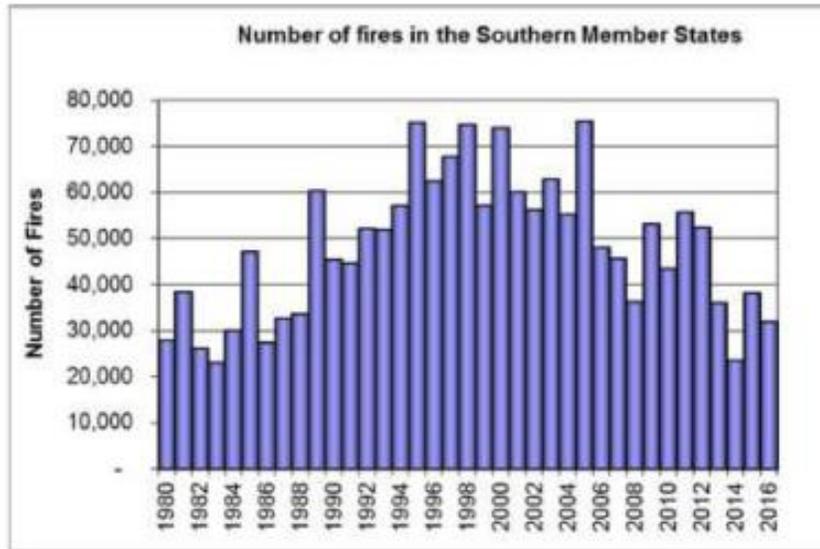
The global picture

- The problem is worsening globally
- Firefighting resources become stronger; technology helps increase effectiveness; the yearly cost is rising... but the problem persists
- A small number of intense fires is responsible for most of the burned area and the damages
- High fire severities cause adverse ecological effects
- It is clear that we are doing something wrong; we need to understand the problem if we want to mitigate it.

Trends in suppression cost and burned area in the USA



Forest fire statistics in the Southern Member States of the European Union



Source: European Forest Fire Information System (EFFIS)

Main current issues about forest fires in the Mediterranean region

- Although the yearly burned area is not increasing damages are on the rise
- Fire behavior is worsening and extreme fires occur somewhere in the Mediterranean every year
- Fire suppression is becoming more challenging; firefighter safety has become a major concern
- Civilians are often threatened by wildfires, especially in the Wildland-Urban Interface (WUI) areas, which have become extensive in the last decades
- The cost of forest fire management is on the rise

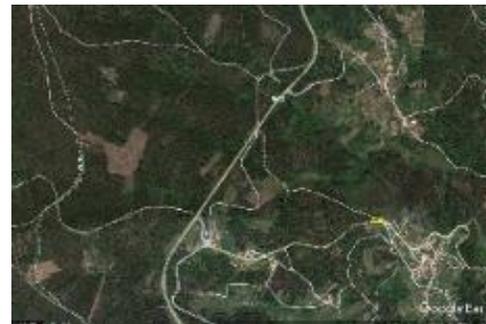
Greece (Aug 24-27, 2007)



78 fatalities, more than 3000 homes destroyed
(Xanthopoulos 2007, Diakakis et al. 2016)

Fire at Pedrogão Grande, Portugal 17-6-2017

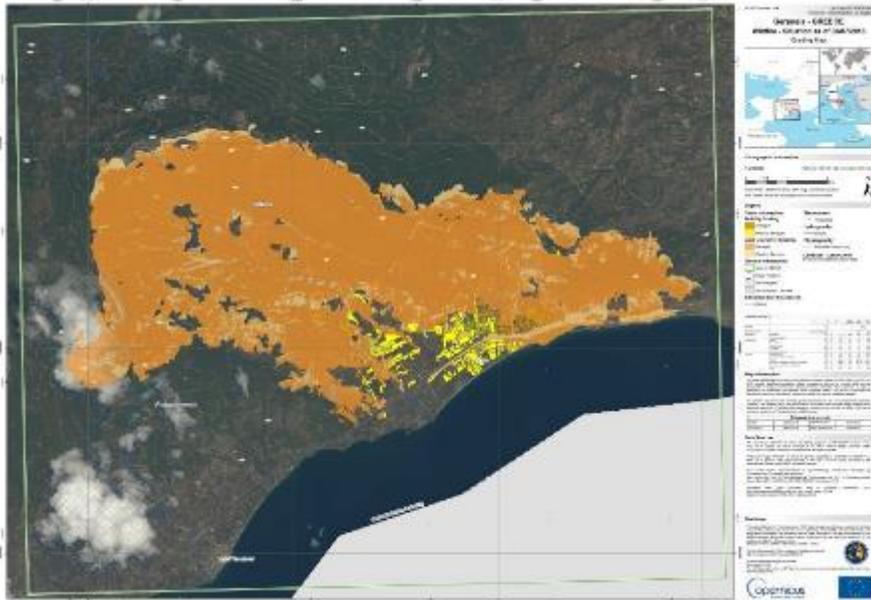
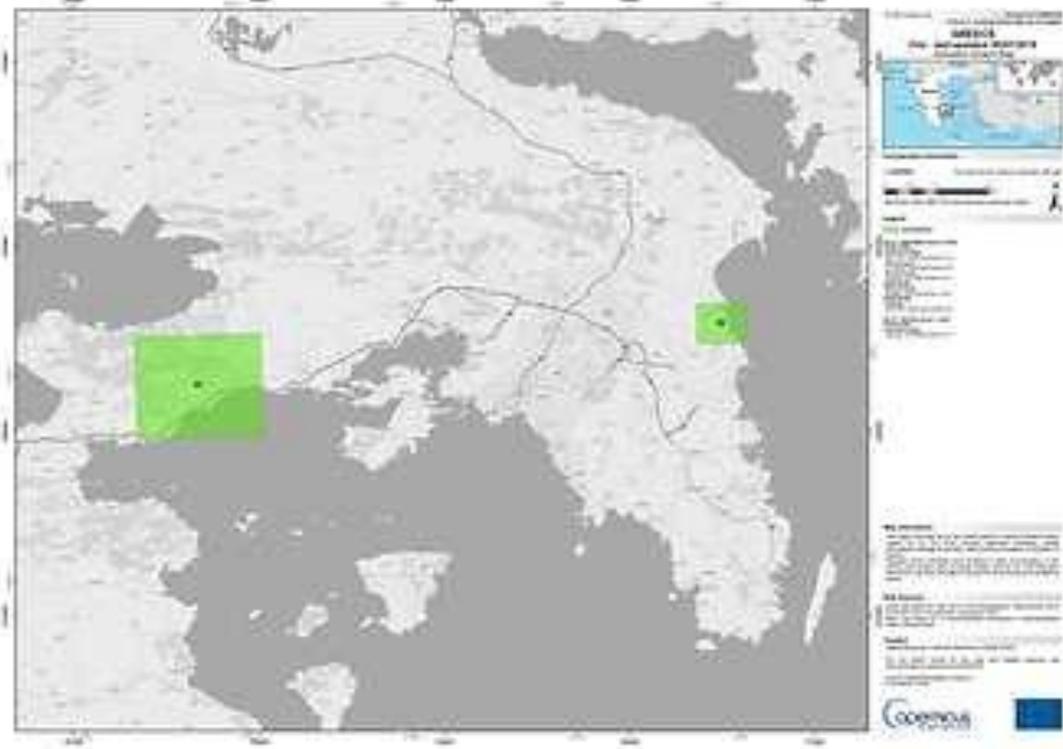
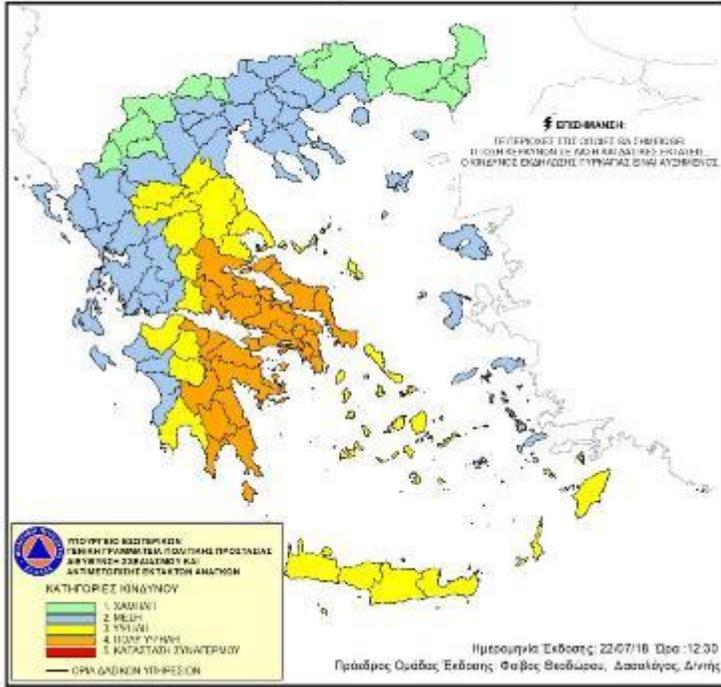
- 64 fatalities, 160 injured, >30,000 ha burned
- Extremely flammable vegetation
- Unprepared communities and citizens
- Inadequate firefighting mechanism for the job



Forest fire disaster in Greece

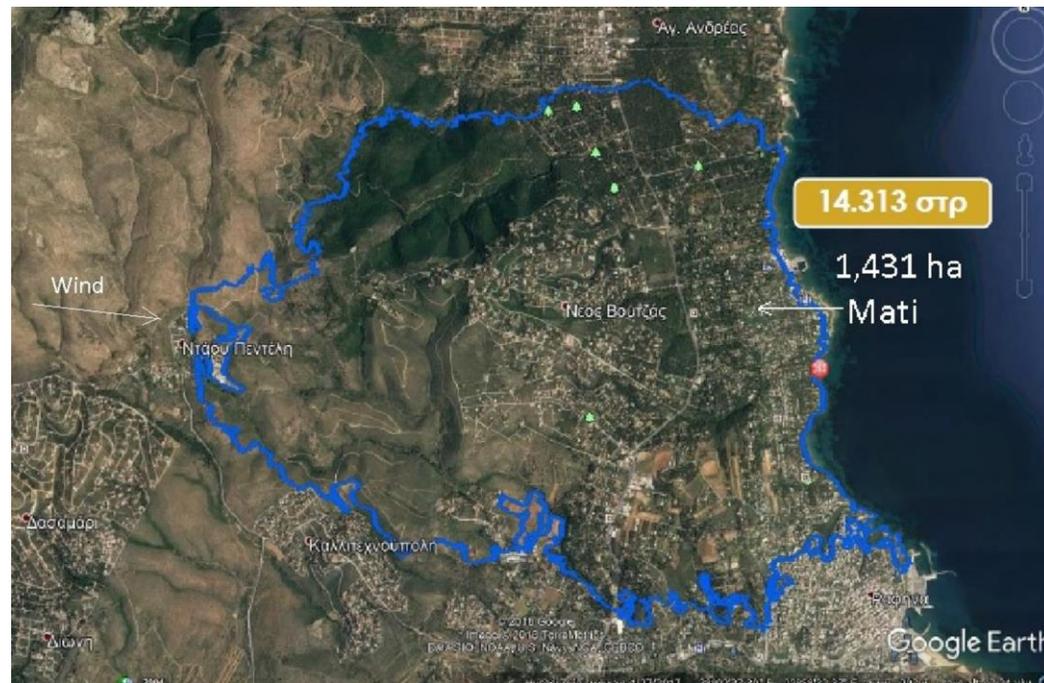
23 July, 2018

**ΧΑΡΤΗΣ ΠΡΟΒΛΕΨΗΣ ΚΙΝΔΥΝΟΥ ΠΥΡΚΑΓΙΑΣ ΠΟΥ ΙΣΧΥΕΙ ΓΙΑ
Δευτέρα 23/07/18**



Eastern Attica fire, Attica, Greece (23-7-2018)

- 99 fatalities, >100 injured
- 1,431 ha burned
- Extreme wind
- Unprepared communities and citizens
- Inadequate firefighting mechanism for the job











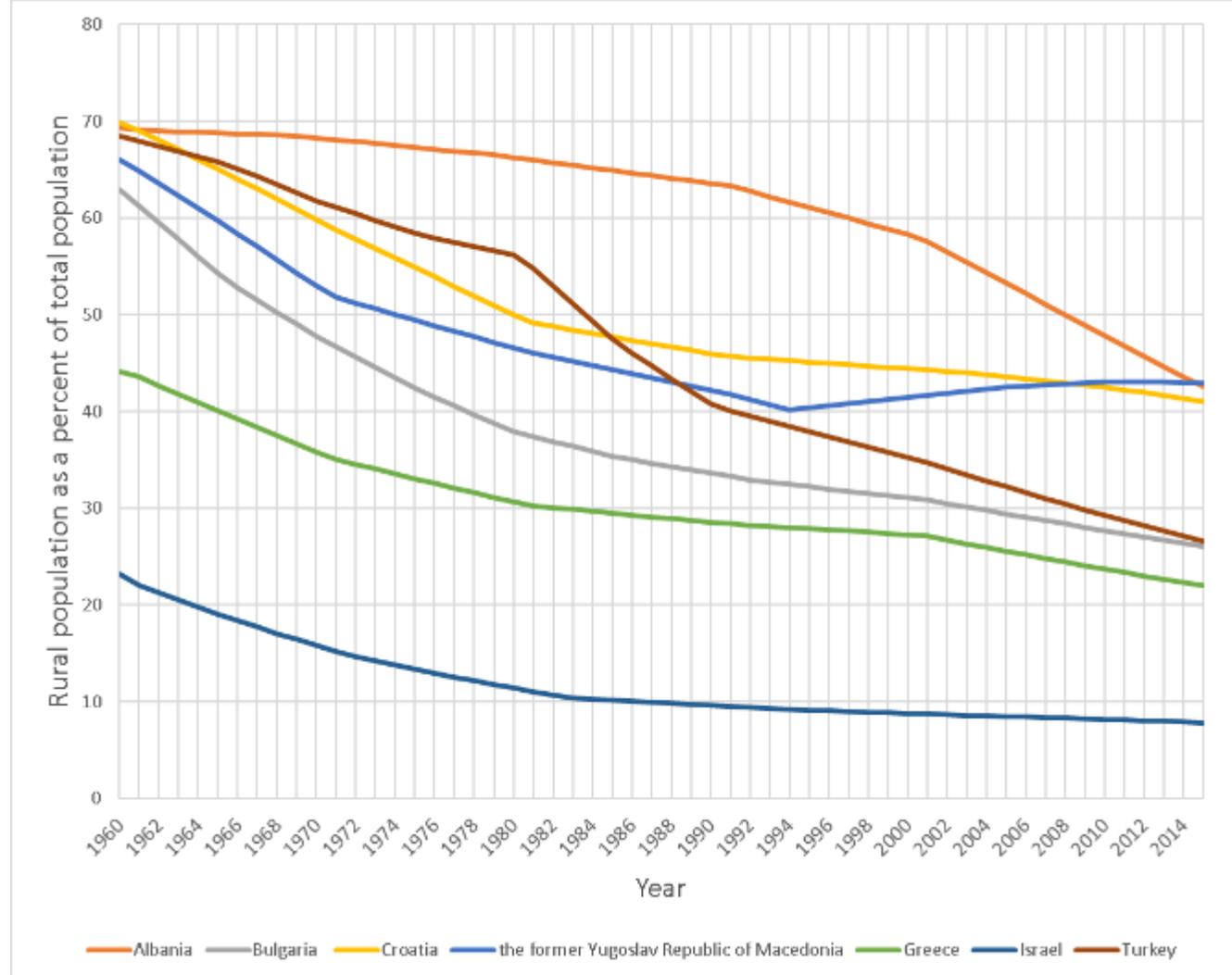
Why are forest fires becoming worse?

- Changes in fuels (fuel built-up)
- Changes in climate and weather conditions (drought periods, extreme wind and rain events, changing circulation of air masses, etc.)
- Development of Wildland-Urban Interface (WUI) areas
- Failures in fire prevention (lack of understanding of its potential content, lack of attention and funding)
- Changes in the population (number, age, capabilities, attitude, behavior)

Changes in forest fuels

- Population decrease in the countryside and land abandonment allows biomass built-up and increased horizontal and vertical continuity
- Forest expansion due to reclaiming of space and artificial regeneration (forest plantations)
- Fire suppression effectiveness increases fuels!



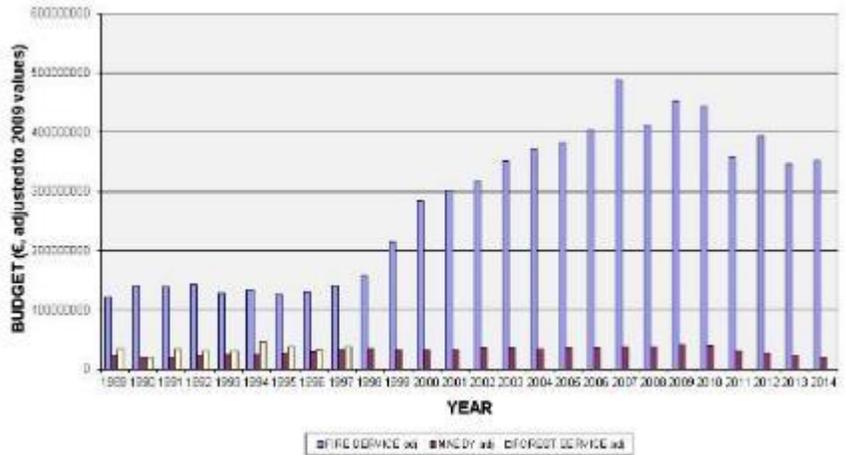
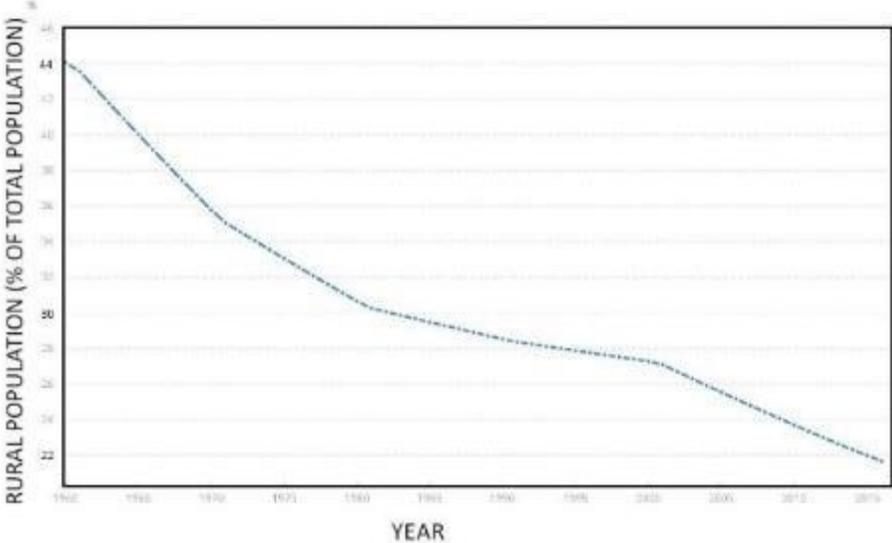
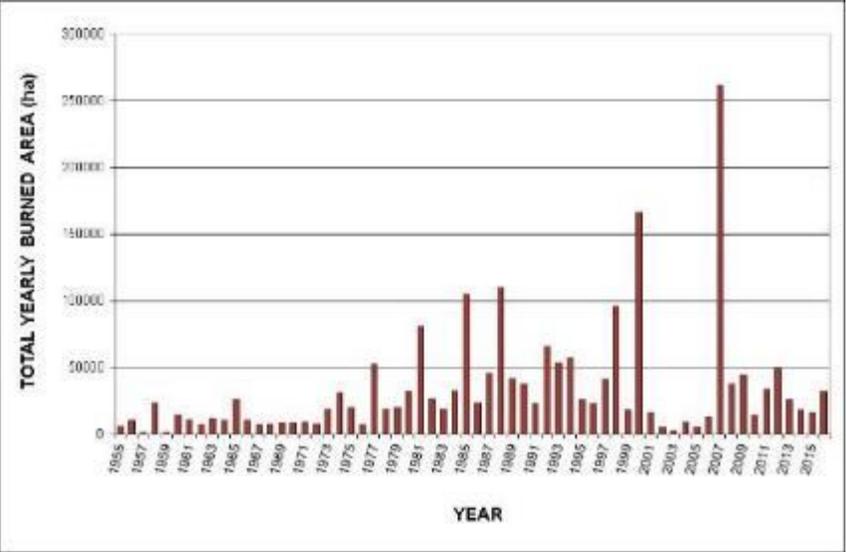


Rural population evolution as a percent of total population in seven countries of the Balkans and Middle East

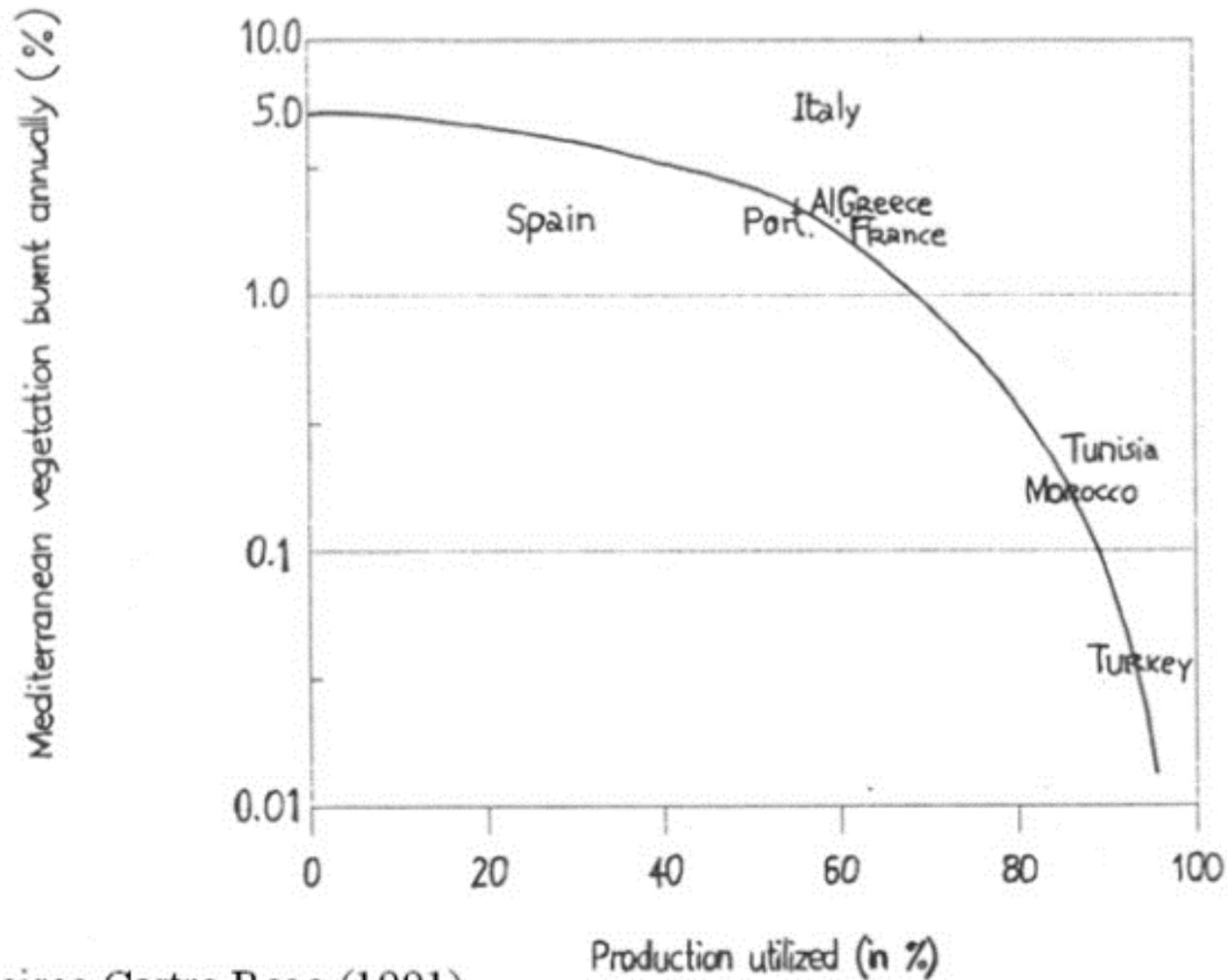
(Source: Xanthopoulos and Nikolov, Fire Management Today, in press

Data from *IndexMundi* (2017)).

Burned area, firefighting cost, and population trends in Greece



Relation between % area burned and % vegetation utilized



Francisco Castro Rego (1991)

Weather changes

- Various changes in drought duration, atmospheric moisture changes, strong cold fronts, etc. leading to extreme fire behavior



Pyrocumulonimbus cloud, Portugal October 2018 (From Marc Castellnou, Spain)

WUI Definition

- A **wildland–urban interface (WUI)** refers to the zone of transition between unoccupied land and human development. Communities that are within 0.5 miles (0.80 km) of the zone may also be included.
- These lands and communities adjacent to and surrounded by wildlands are at risk of wildfires (Wikipedia).
- A concept first developed in the USA.
- In Mediterranean Europe and elsewhere following land abandonment, we now also have **Rural-Urban Interfaces (RUI)**

Unprepared WUIs and citizens

Classification of houses according to their risk of destruction due to a fire in a WUI in Greece



Poor population preparation



Portugal in mourning as battle continues to control fires

Death toll rises to 63, with many trapped in their homes or killed trying to flee in cars

By Mark, Jun 16, 2017, 19:43

By Reddyman in Brazil



A turned car stands on its side on the road near Casalinhos de Pera, in Lameira district, Portugal. Photograph: Pablo Blazquez Dominguez/Getty Images



In pictures: Portugal fires

“

The cars were crashing into each other as they tried to escape

Pedrógão Grande saw harrowing scenes on Saturday and Sunday as many people were trapped by flames in or near their homes, while many others died in their cars as they attempted to flee.



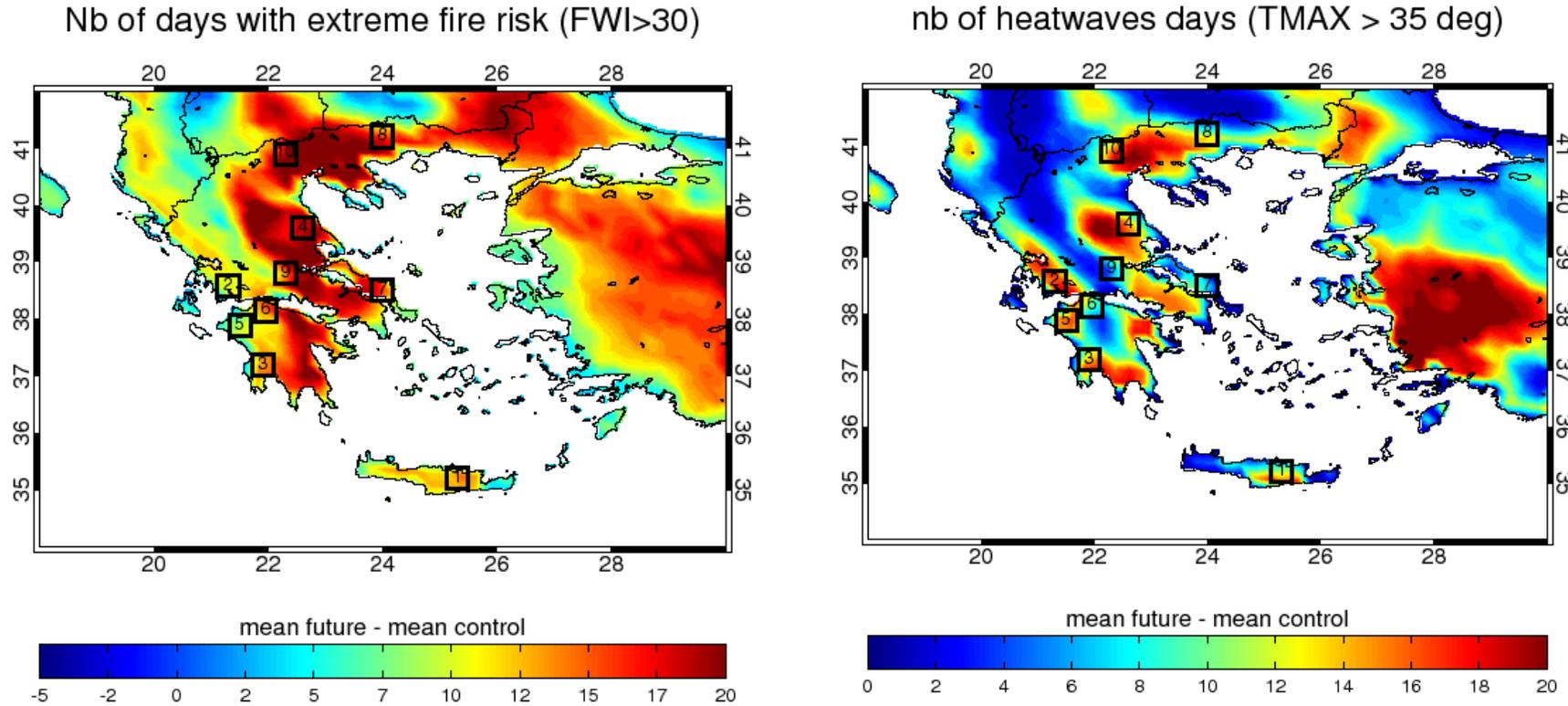
Climate change and forest fires

- Climate change is expected to influence forest fires through its influence on the forest vegetation itself, but also due to changes in weather phenomena that affect forest fire start and spread.
- It is also likely to affect rural population dynamics
- Regarding forest vegetation it is predicted that climate change will affect the distribution of forests, the species composition, the biodiversity, etc.)
- As conditions (e.g. of drought, temperature, etc.) exceed the thresholds of tolerance of certain forest species, these will certainly be affected. It is likely they will face increased mortality and replacement by more tolerant species.

Forest mortality and regeneration

- Mortality may be caused by insects, diseases, wind-throws, snow-throws.
- Forest fire can be a direct effect due to climate change (as expressed by changes in meteorological conditions) or may come as a clearing agent of the already dying forests.
- In any case, the forest fire problem is likely to become much worse.
- Post-fire regeneration may not be secured, especially if the affected forests are not composed of fire tolerant species (e.g. *Abies cephalonica*).

Predicted effects of climate change on fire risk in Greece



Change in the number of days with increased fire risk (FWI>30), and very hot days (TMAX >35° C) in Greece, between the 1961-1990 and the 2021-2050 period.

Giannakopoulos et al. 2010

Forest fire regimes

- Forest fire regimes (i.e. the pattern, frequency, and intensity of forest fires that prevail in an area over long periods of time) will be altered.
- Higher frequency may impede natural regeneration
- Very large burned areas resulting from single fires or combination of more fires in bad fire seasons may have truly catastrophic results, including serious effects on regional economies, damages to infrastructures, extensive erosion and flooding, etc.
- Extreme fire intensity may result in more fatalities of firefighters and citizens. It will also be linked to higher fire severity, with stronger negative environmental effects.

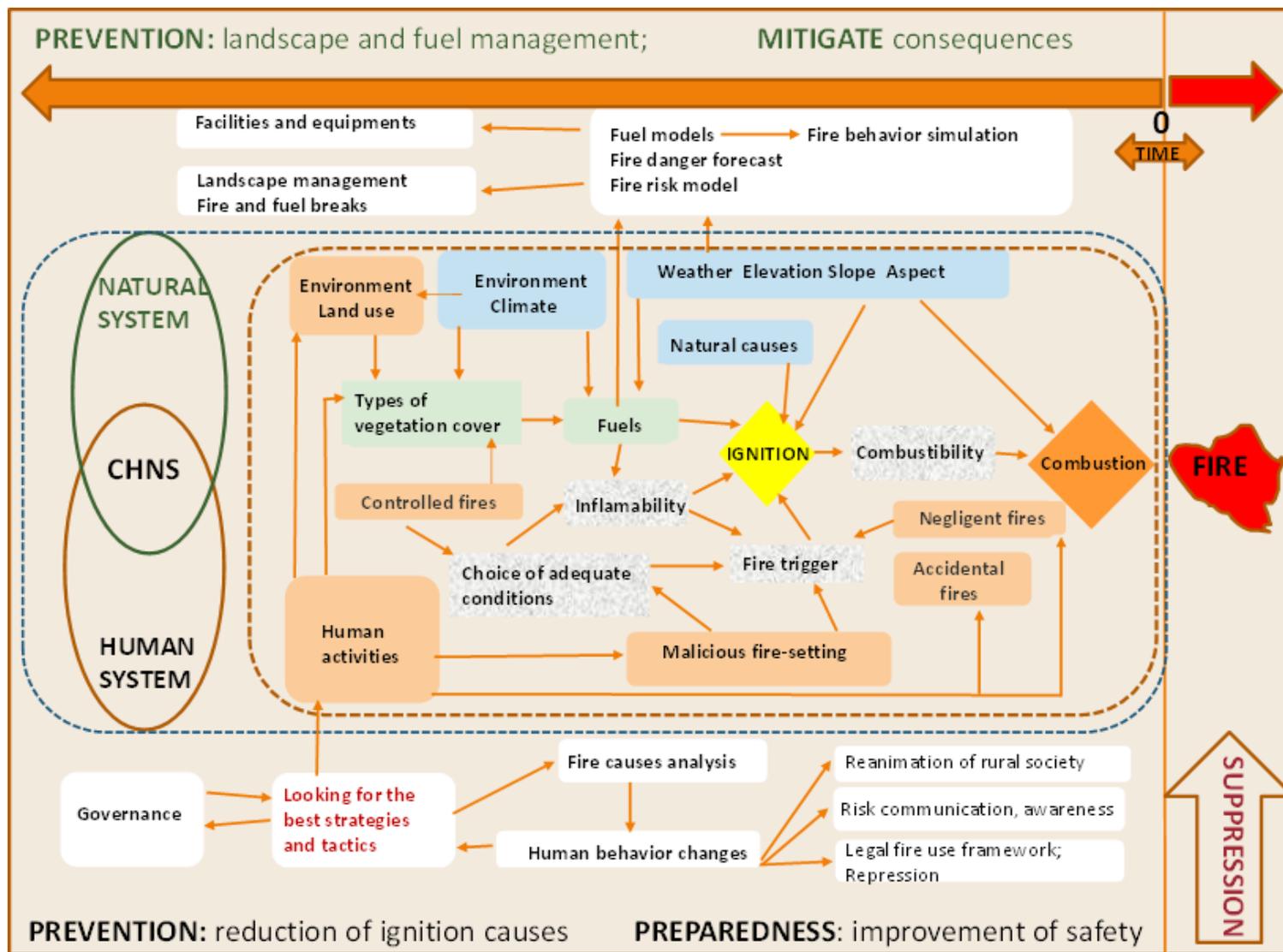
Population changes and forest fires

- Rural areas abandonment, especially by young people, because living there is not attractive anymore (poor economy due to current policies (globalization, CAP), lack of conveniences and infrastructures, etc.). This results in:
 - Forest fuel build-up
 - Vulnerability of Rural-Urban Interface areas
 - Fewer able hands available to help with fire suppression
- International immigration (influenced by CC and international policies, wars, etc.)
 - May affect rural areas abandonment (e.g. new workers)
 - May affect probability of ignition due to lack of understanding about fires
 - May include a risk of use of fire for terrorism

The way forward

Creation of fire-smart landscapes

- As we cannot predict with certainty the extent of Climate Change, and its exact manifestations in space and time, and we have no immediate control over international policies, wars, etc., we can only act based on our current understanding of the factors affecting the problem as outlined here.
- We can work on creating resilient, “fire-smart” landscapes in the agro-forestry space:
 - Change agricultural policies as needed (create financial incentives for rural people, support them and empower them to act on the land in ways that they will make it fire safe)
 - Make forests “useful” for local populations by increasing their output that brings income to the rural populations
 - Put emphasis on resilient post-fire recovery



The Coupled Human and Natural System: a synthetic view of components, human and natural ignition causes, and possible initiatives for disaster risk reduction (Tedim et al. 2016).

The concept of Fire Smart Territory (FST)

- FST: “A fire prone territory in which the integration of economic and social activities aimed at risk reduction and conservation on natural values and ecosystem services is accomplished by aware and well trained empowered communities, able to decide the objectives and practices for preventing, controlling or utilizing fire”
- Note on the use of the word “Territory”:
 - Whereas landscape is not a tangible reality but its picture, as the result of perception, territory is a portion of geographical space, closely *“interconnected with society on different spatial, temporal and social scales”*. (Tedim et al. 2016).

Improve fire management

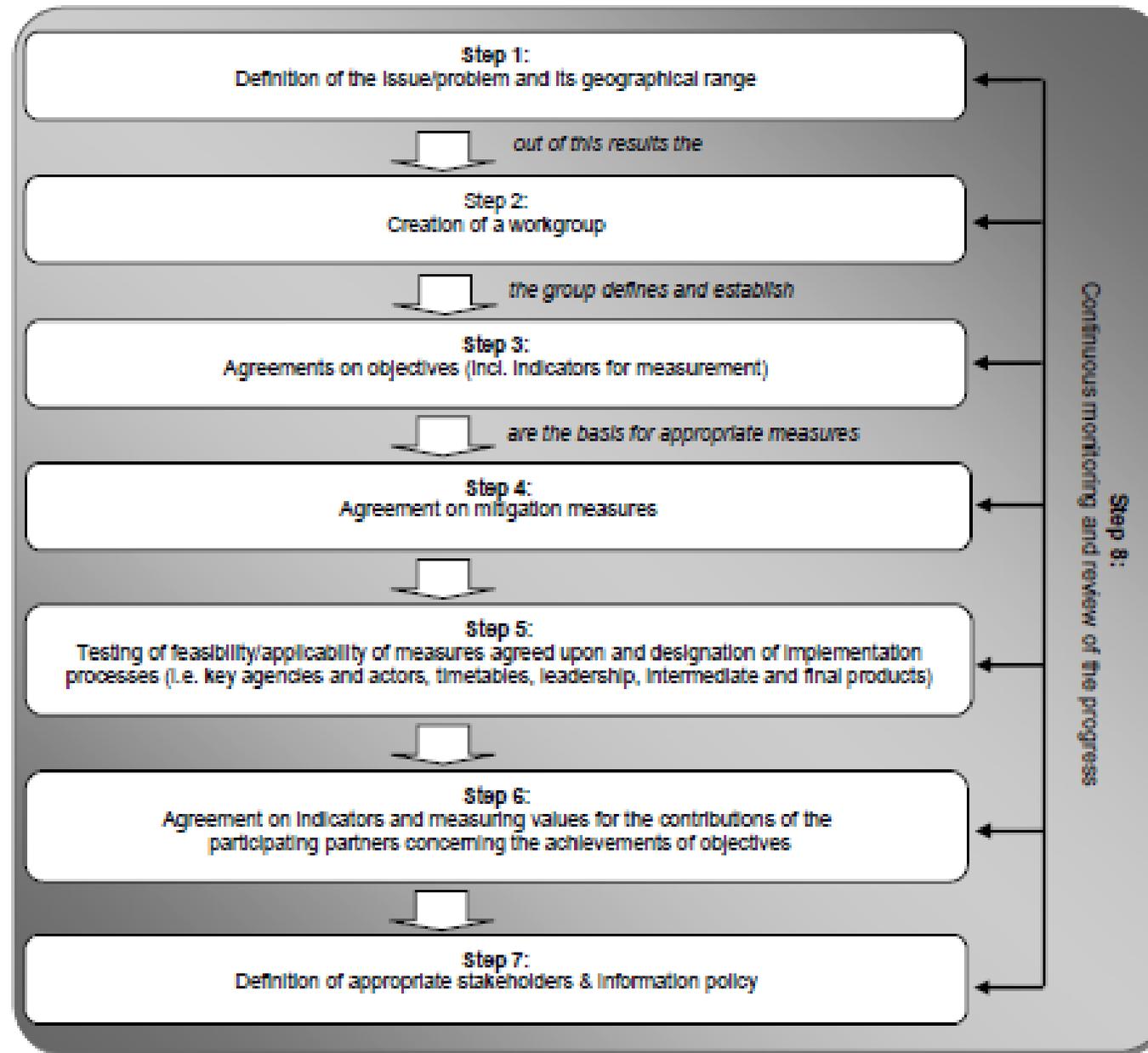
- Firefighting must become not only effective but also efficient. This requires systems that can call upon all available resources and people who need to be knowledgeable, trained and motivated.
- This will be necessary to address emergencies.
- Land management organizations, especially Forest Services, cannot be excluded from fire suppression.
- It must be based on state of the art knowledge, regarding the whole spectrum of forest fire science, not only technical resources.

Fire prevention

- Threefold effort
 - Avoidance of fire starts (Fire danger prediction, mobilization, fire detection)
 - Fuel reduction (fuel management projects, territory use by the population)
 - Preparation of the citizens
 - Message: Fire is unavoidable; there is no guaranteed protection
 - Learn what to do, to prepare and to act
 - WUI preparation from municipality to individual citizen level, to reduce damages
- Year round effort is needed (appropriate agency, personnel, funds, innovative and clever legislation, appropriate approach for the task)
- Specialists from different relevant fields should contribute (sociology, criminology, educators, advertisers, etc.)

The “INCA” methodology

- A methodology, called “INCA”, has been developed in 2009-2010 in the frame of a project titled “**Linking civil protection and planning by agreement on objectives**” (INCA), which was partially funded by the Civil Protection Financial Instrument of the European Commission (Grant Agreement reference n° 070401/2008/507855/SUB/A3).



The steps of the INCA participatory process



ΑΘΗΝΑ 14-3-2013



ΘΕΡΜΗ 27 & 28-3-2013



ΑΘΗΝΑ 10-4-2013



ΡΟΔΟΣ 18-4-2013



ΜΥΤΙΛΗΝΗ 24-4-2013



ΧΙΟΣ 27-4-2013



ΑΘΗΝΑ 14-5-2013



ΛΑΜΙΑ 17-5-2013

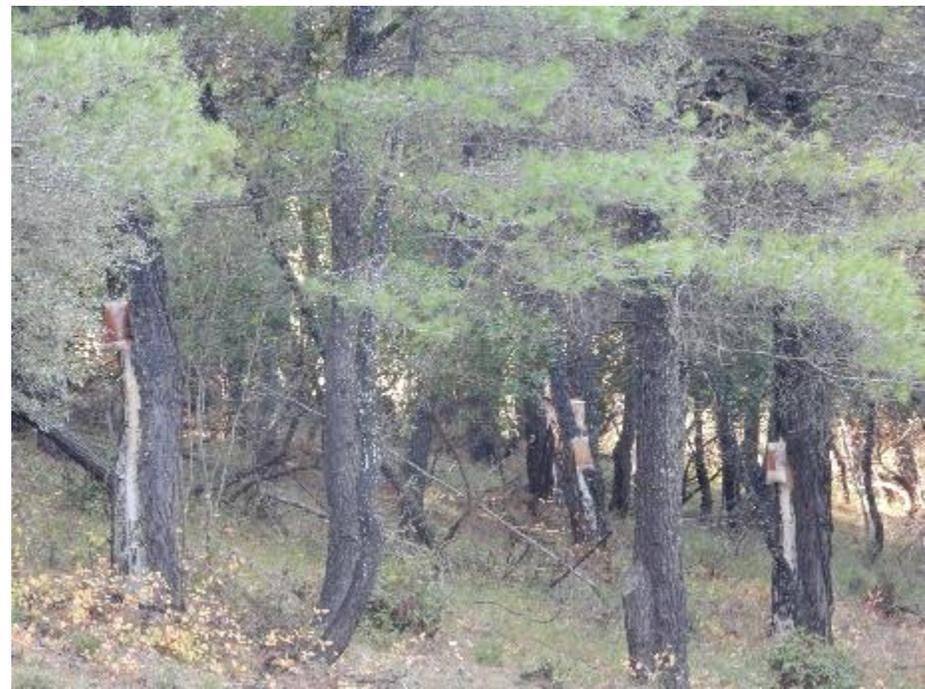


ΠΥΡΓΟΣ 16-6-2013

Well prepared vineyards and olive groves contribution to fire prevention







Post-fire rehabilitation

- Application of measures only where needed, based on objective scientific criteria:
 - Erosion prevention measures
 - Dead standing timber removal
 - Natural regeneration protection
 - Reforestation
- Musts:
 - Effort to improve resilience of future stands, taking climate change into consideration (e.g. Species selection)
 - Avoidance of creation of fuel continuum
 - Resilient recovery of WUI and RUI areas

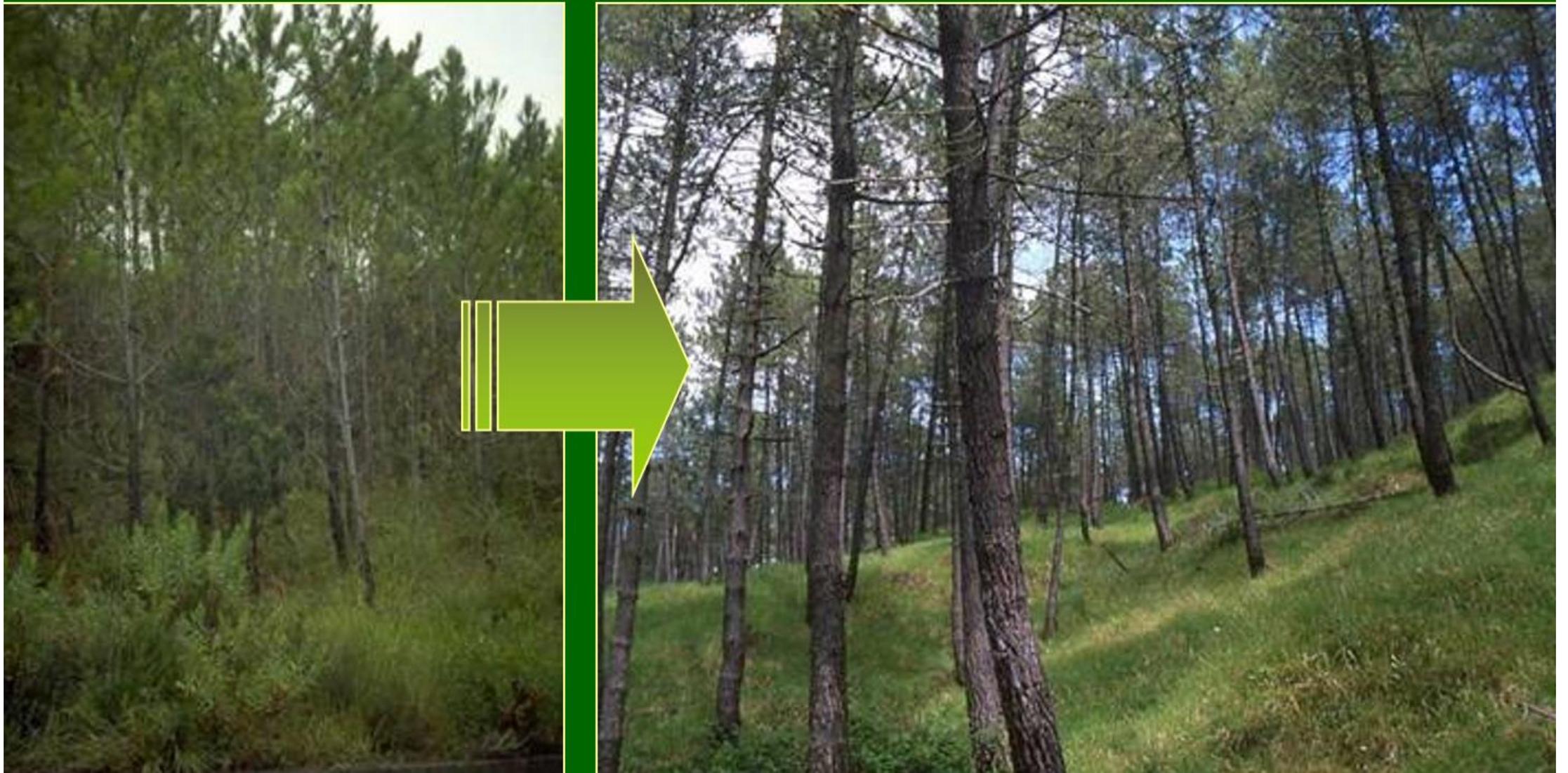
Regarding forest management

- Aim to create a mosaic of forest types and forest species. Prefer resilient species, avoid highly flammable species (e.g. eucalypts)
- Limit spatial continuity (especially regarding forest plantations)
- Maintain low dead fuel loads on the ground
- Aim for creating distance between the surface fuels and the bottom of the crowns (avoid vertical continuity)
- Carry out threat analysis and, based on this, plan for breaks of fuel continuity (firebreaks and fuelbreaks)





Thinning & clearing of stands



WUI and RUI areas

- Take all needed measures for improving the safety of existing such areas, including city planning, infrastructure creation (e.g. water tanks, hydrants, etc.), vegetation treatment, etc.
- Improve future planning of WUIs
- Educate and train the people in order to act for fire safety in their property.
 - They should know how to avoid becoming arsonists due to negligence, and how to report risky behavior of others and fires they may detect.
 - They should know how to manage vegetation in their property for fire safety and how to make their home safer
 - They should be prepared for an emergency, knowing in advance what to do. Obviously, they should learn how.

Opportunities

- A lot depends on the ownership of forests in a country. Opportunities are in the public or private sector accordingly.
- Innovation opportunities may arise:
 - In the fire prevention sector
 - Fuel management (and maintenance)
 - Forest biomass use for energy
 - Population organization, guidance, training
 - Technical infrastructure development (water tanks, hydrants, roads, cameras etc.)
 - Knowledge/IT services (fire danger prediction, threat analysis,...)
 - Home protection infrastructure
 - In the fire suppression sector:
 - Fire suppression services (e.g. aerial firefighting)
 - Support to volunteers
 - Fire suppression technical innovations (e.g. tools)
 - ...

Opportunities (2)

- In the post-fire rehabilitation sector
 - Planning
 - Erosion prevention works
 - Assessments, paperwork for people
 - Technical support (homes & infrastructure repairs)
 - Introduction of new initiatives (new products,...)

THANK YOU