

Remote Sensing of Forests and Forest Fires in Europe

Lorenzo Busetto, Jesus San Miguel, Andrea Camia

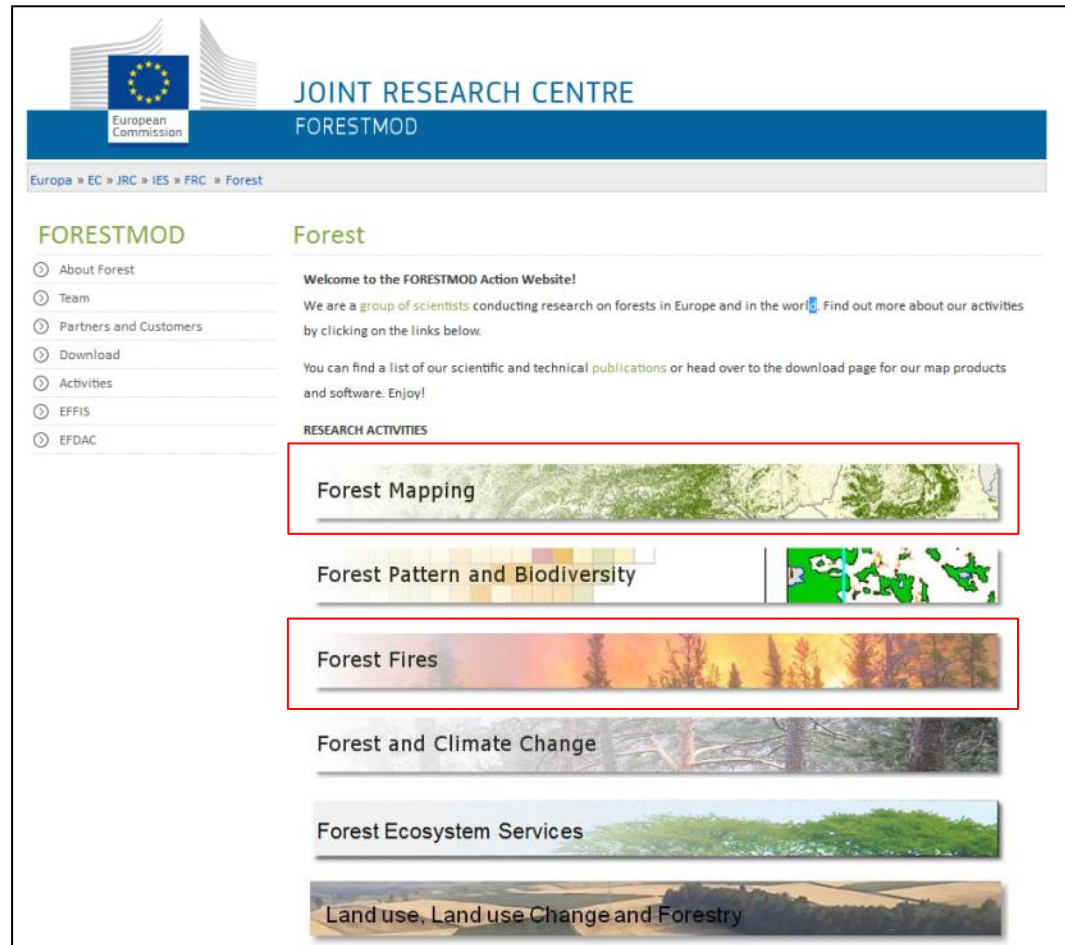
FOREST RESOURCES AND CLIMATE UNIT
Institute for Environment and Sustainability
Joint Research Centre - Ispra

17.06.2013

The FORESTMOD Action (Forest Modeling and Information Systems)

<http://forest.jrc.ec.europa.eu/>

- Analyzing the role of forests in providing economic benefits (e.g. timber, biomass for renewable energy, etc.) and ecological services (biodiversity, soil and water protection, etc.), at European level
- Developing maps, models and information systems related to forestry, enabling improved accessibility to information through the **European Forest Data Centre (EFDAC)**



FOREST MAPPING and MONITORING

- The activity of the Forest Mapping group had been “historically” focused on developing **Pan European Forest maps** characterized by the following main features:
 - ✓ Consistent over Europe
 - ✓ Independent of national boundaries
 - ✓ Higher level of spatial detail than previously available (e.g. able to detect small patches or non-forest openings and corridors)
 - ✓ High level thematic accuracy
 - ✓ Compatible with INSPIRE standards

FOREST MAPPING and MONITORING

Main Outcomes

Forest Cover 2000 Map

- ✓ <http://forest.jrc.ec.europa.eu/activities/forest-mapping/forest-cover-map-2000/>

Forest Cover 2006 Map

- ✓ <http://forest.jrc.ec.europa.eu/activities/forest-mapping/forest-cover-map-2006/>

Forest Type 2006 Map (Coniferous/Broadleaved)

- ✓ <http://forest.jrc.ec.europa.eu/activities/forest-mapping/forest-type-map-2006/>

FOREST MAPPING and MONITORING

Forest/Non-Forest Map 2000

Input Data

- ca. 400 Landsat ETM scenes (GLCF+Image2000);
Shuttle Radar Topography Mission (STRM), Version2

Training Data

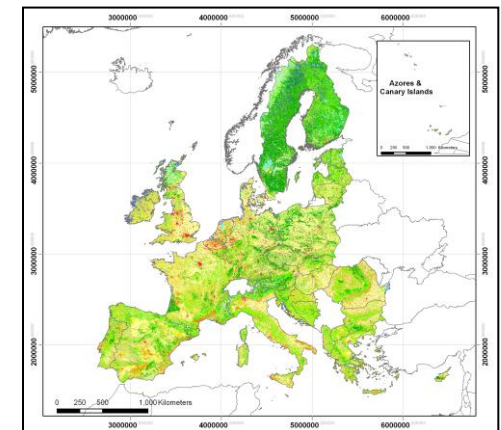
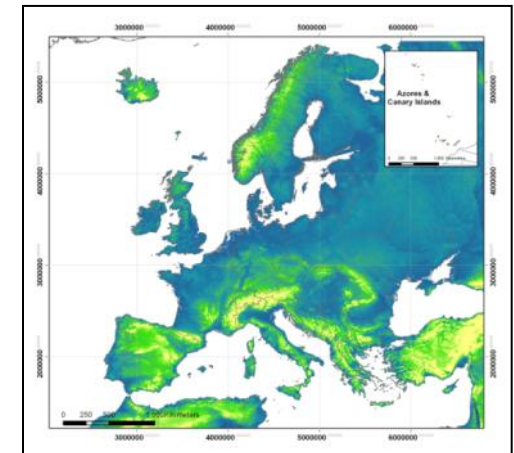
- CORINE Land Cover 2000 (44 Land use/cover classes)

Processing Method

- Per-scene supervised classification after segmentation of images (k-NN classifier)

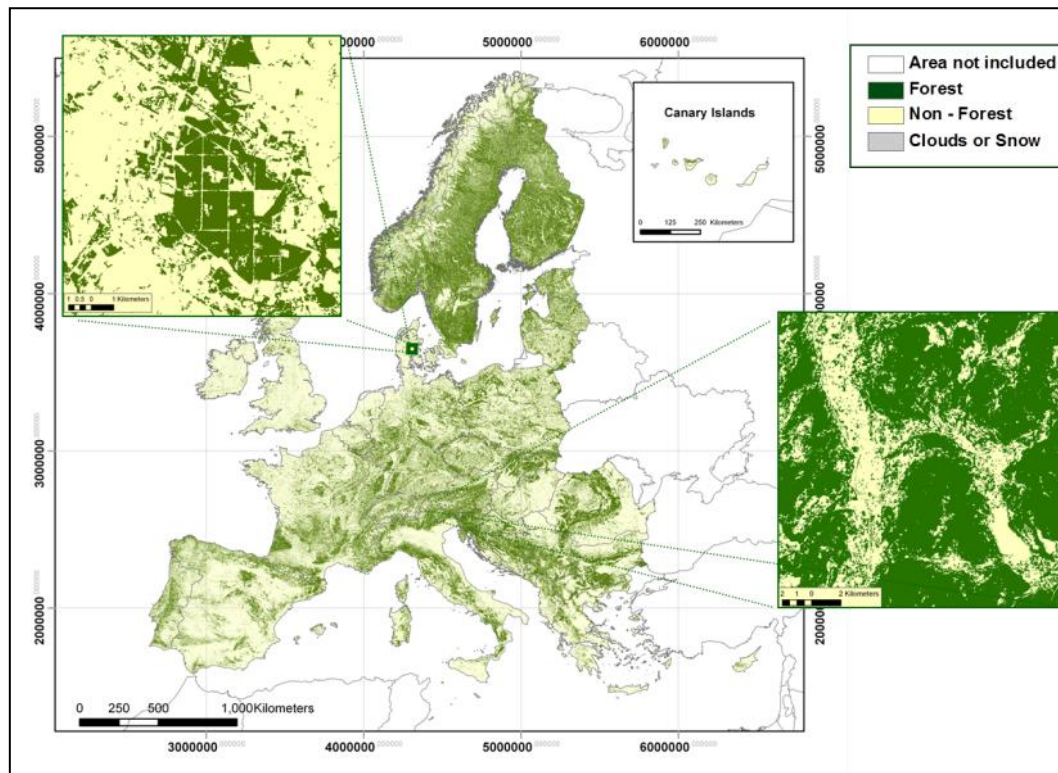
Validation

- Visual validation against google earth
- Against LUCAS dataset



FOREST MAPPING and MONITORING

Forest/Non-Forest Map 2000



Pekkarinen, A., Reithmaier, L. & Strobl, P. 2009. *Pan-European forest/non-forest mapping with Landsat ETM+ and CORINE Land Cover 2000 data*. ISPRS Journal of Photogrammetry and Remote Sensing

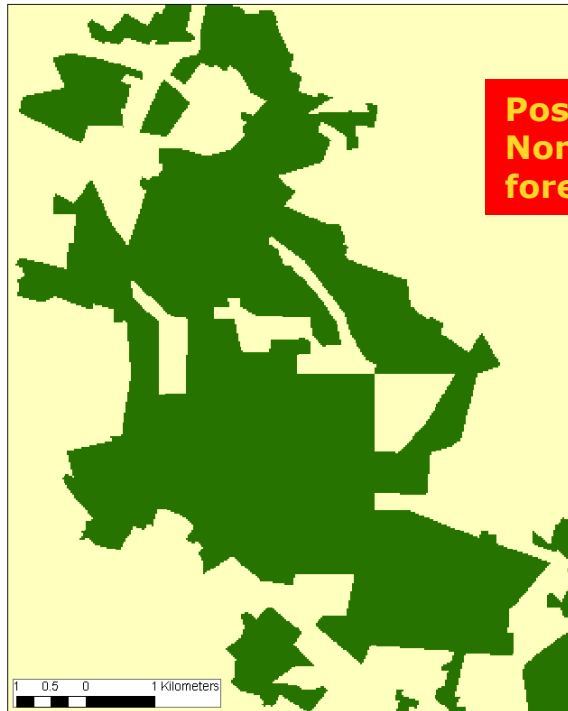
FOREST MAPPING and MONITORING

Forest/Non-Forest Map 2000

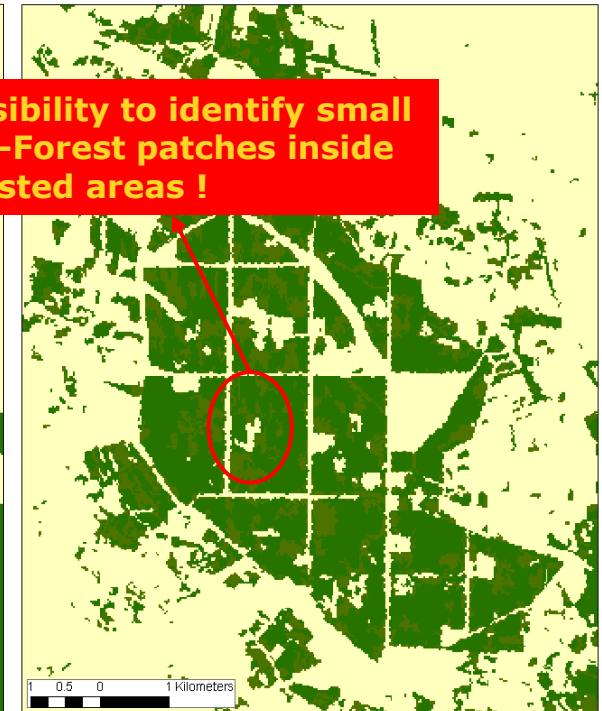
Landsat ETM+:



CORINE 2000:



Forest/Non-forest:



**Possibility to identify small
Non-Forest patches inside
forested areas !**

FOREST MAPPING and MONITORING

Forest/Non-Forest and Forest Type Map 2006

Input Data

- More than 2000 scenes (SPOT/LISS III) (Image2006)
- MODIS 250 m monthly composites (For forest type discrimination)

Training Data

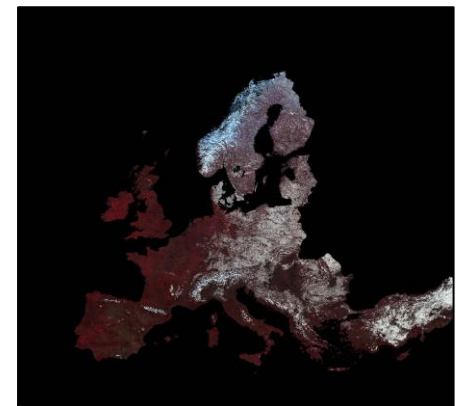
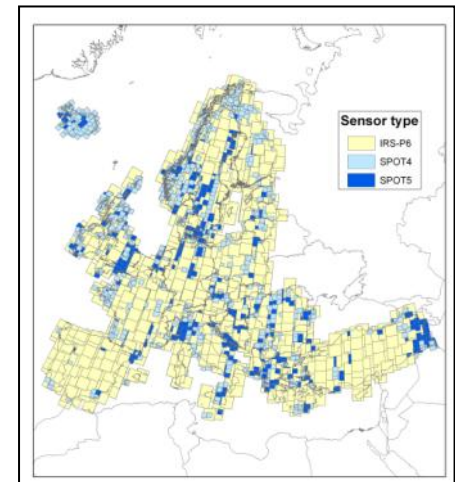
- CORINE Land Cover 2000-2006

Processing Method

- Per-scene supervised classification of Image 2006 data (Neural Network classifier) for Forest/Non Forest layer production
- Data fusion with MODIS data followed by NN classification for Forest Type classification

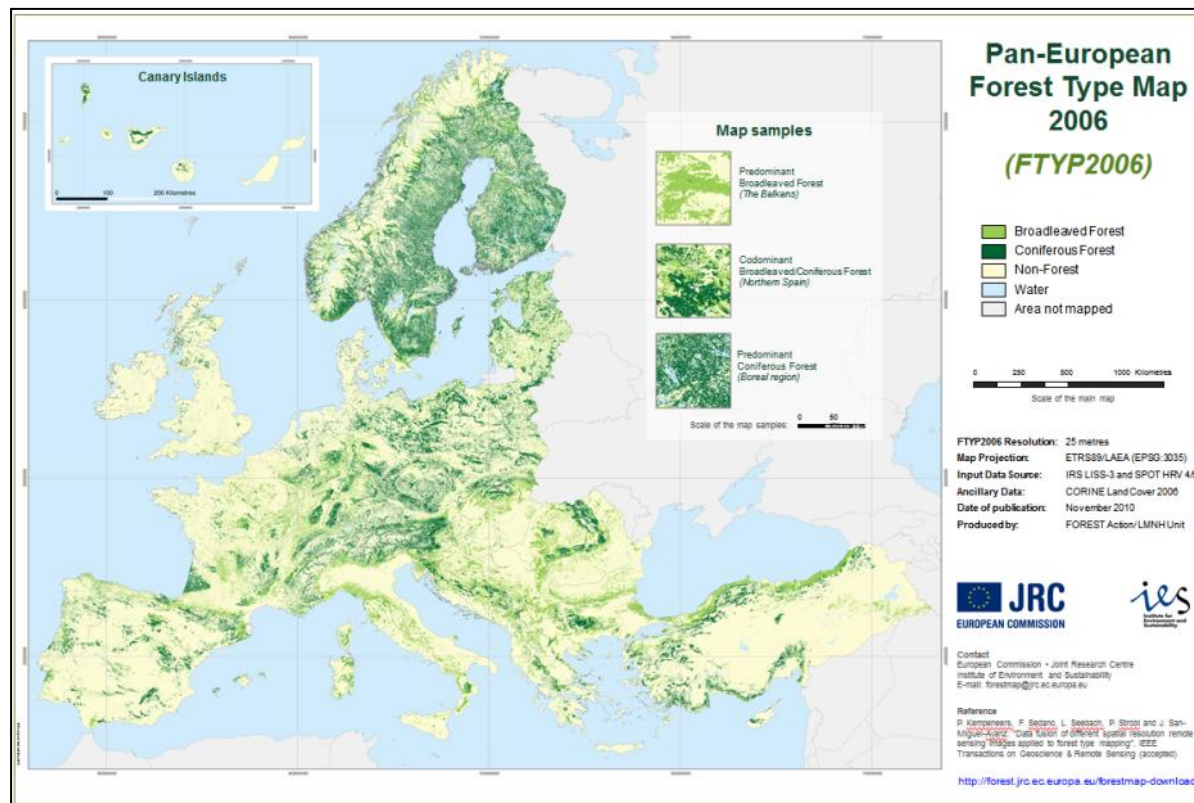
Validation

- Visual interpretation of Google earth image data
- National Forest Inventory data



FOREST MAPPING and MONITORING

Forest/Non-Forest and Forest Type Map 2006

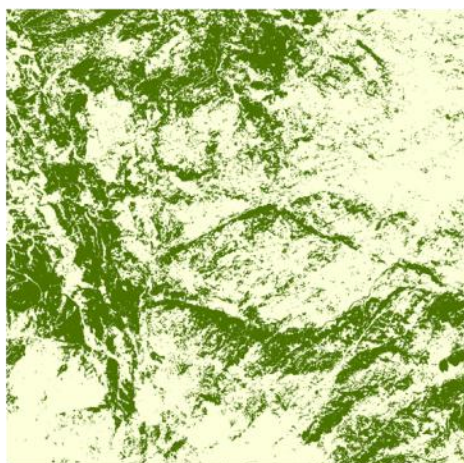


Kempeneers, P. et al. (2011) Data Fusion of Different Spatial Resolution Remote Sensing Images Applied to Forest-Type Mapping. IEEE Transactions on Geoscience and Remote Sensing

FOREST MAPPING and MONITORING

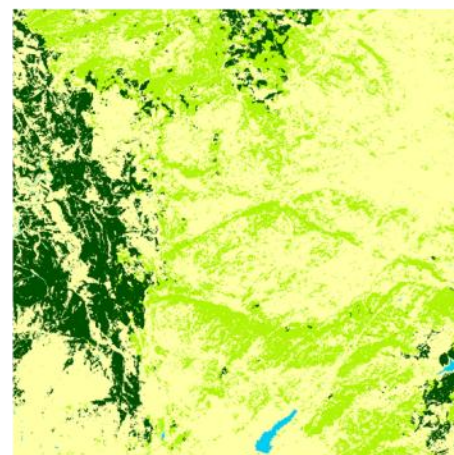
Forest/Non-Forest and Forest Type Map 2006

Forest/Non-Forest map



- Non-Forest
- Forest

Forest type map



- Non-Forest
- Broadleaved Forest
- Coniferous Forest
- Water

FOREST MAPPING and MONITORING

- Produced maps are useful for
 - ✓ Analysis of variations in forest area (e.g., used for FRA2010 RS survey in Europe)
 - ✓ Analysis of pattern, fragmentation and connectivity indicators
 - ✓ Inputs for small scale models (e.g., Primary production models)
 - ✓ “Starting point” for analysis of the effects of climate change on forests

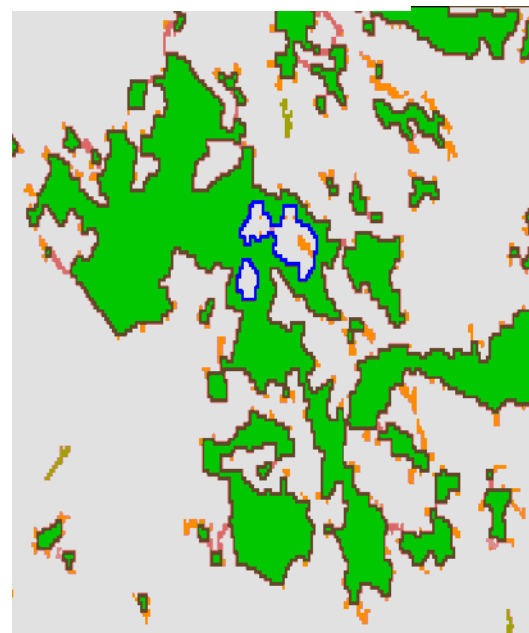
FOREST MAPPING and MONITORING

Morphological Spatial Pattern (MSPA) maps

From a forest mask to....



A forest spatial pattern map



- Core forest
- Edge
- Branch
- Connector : bridge
- Connector : loop
- Perforation edge
- Islet

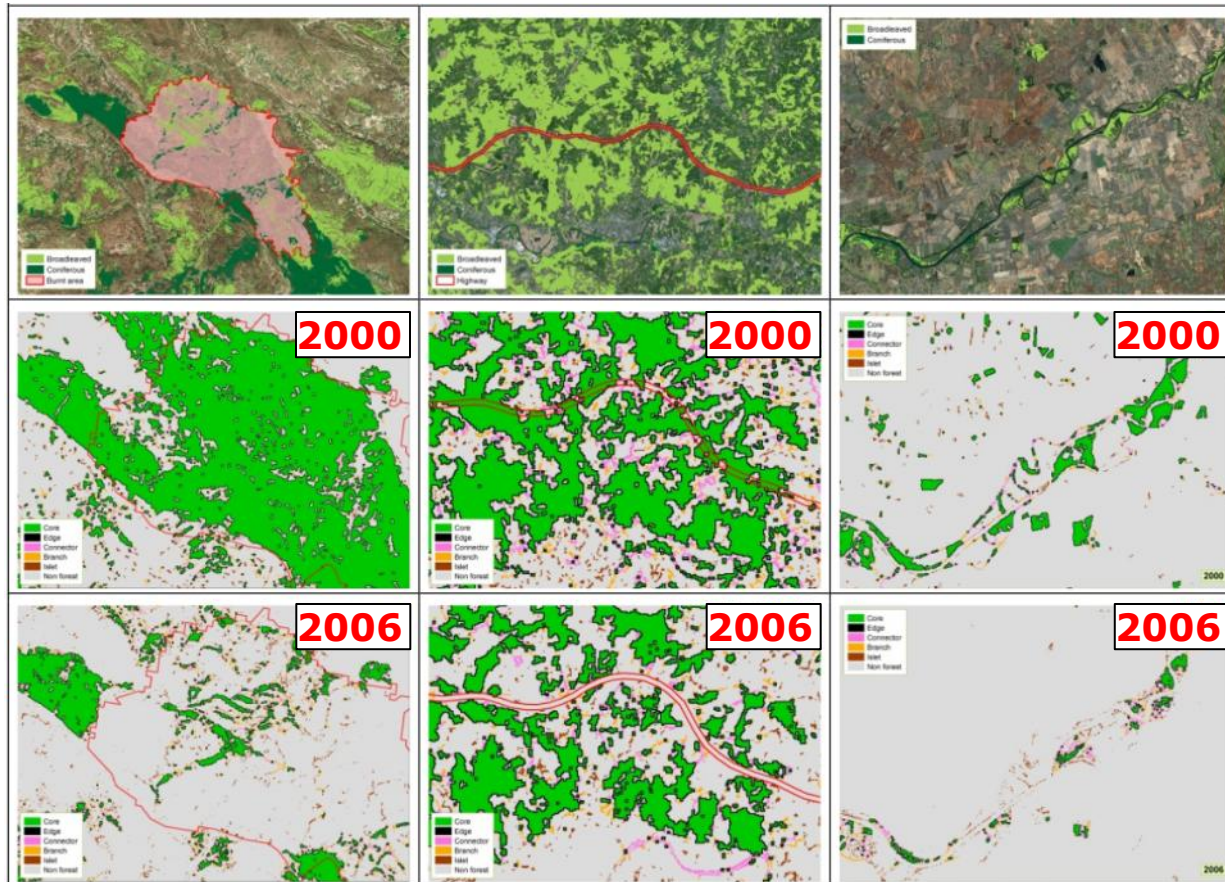
Derived using Morphological Spatial Pattern Analysis
(MSPA-[Guidos](http://forest.jrc.ec.europa.eu/download/software/guidos) freeware developed by the JRC)
downloadable at: <http://forest.jrc.ec.europa.eu/download/software/guidos>

FOREST MAPPING and MONITORING

Morphological Spatial Pattern (MSPA) maps

LARGE FIRES

INFRASTRUCTURE FOREST CLEARANCE

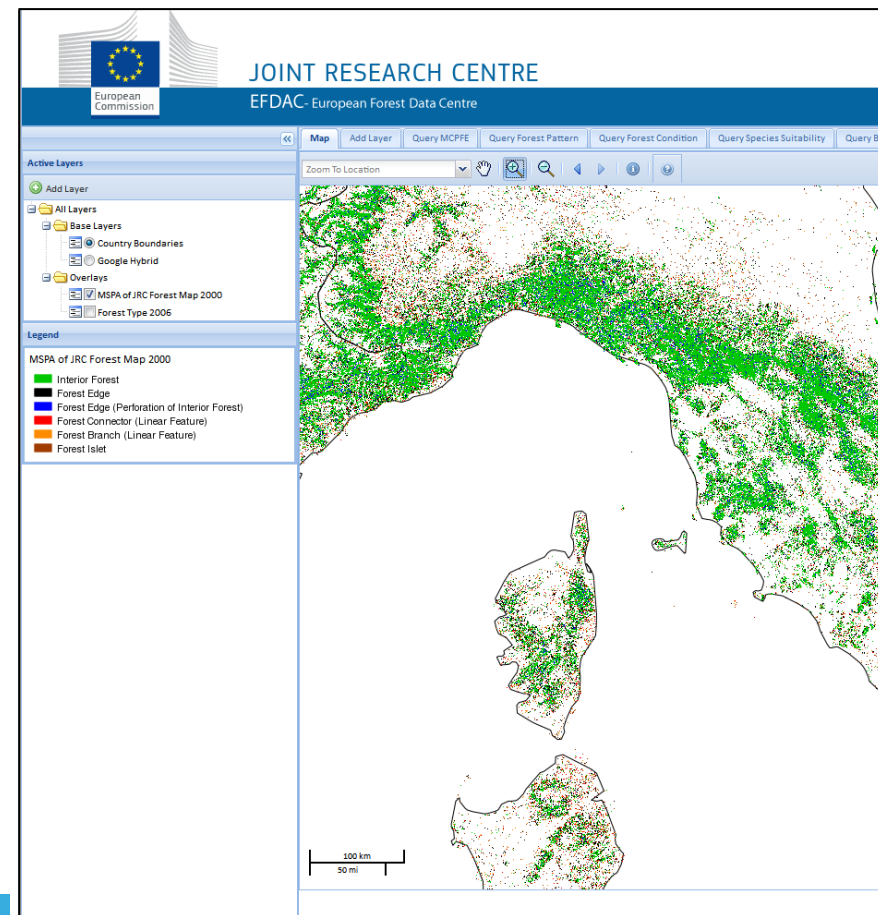


FOREST MAPPING and MONITORING

Data Distribution

- Visualization through the EFDAC web viewer:

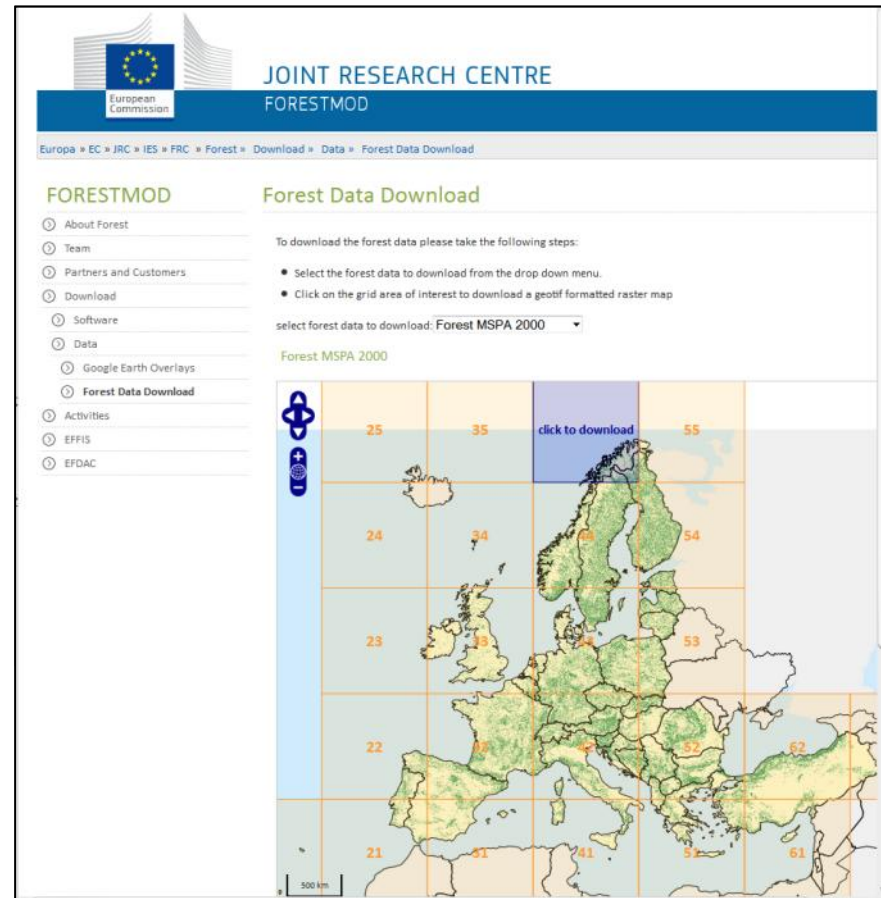
<http://forest.jrc.ec.europa.eu/efdac/applications/viewer//>



FOREST MAPPING and MONITORING

Data Distribution

- Visualization through the EFDAC web viewer:
<http://forest.jrc.ec.europa.eu/efdac/applications/viewer//>
- Download as geotiff through the FORESTMOD action website:
<http://forest.jrc.ec.europa.eu/download/data/>



The screenshot shows the FORESTMOD website interface. At the top, there is a header with the European Commission logo and the text "JOINT RESEARCH CENTRE FORESTMOD". Below the header, a breadcrumb trail reads: "Europa » EC » JRC » IES » FRC » Forest » Download » Data » Forest Data Download". The main content area is divided into two columns. The left column, titled "FORESTMOD", contains a list of links: "About Forest", "Team", "Partners and Customers", "Download", "Software", "Data", "Google Earth Overlays", "Forest Data Download", "Activities", "EFFIS", and "EFDAC". The right column, titled "Forest Data Download", contains instructions: "To download the forest data please take the following steps:", "Select the forest data to download from the drop down menu.", "Click on the grid area of interest to download a geotiff formatted raster map". Below these instructions, there is a dropdown menu labeled "select forest data to download: Forest MSPA 2000". Underneath the dropdown, the text "Forest MSPA 2000" is displayed. The main part of the right column is a map of Europe with a grid overlay. Each grid cell contains a number. A blue box with the text "click to download" is positioned over the grid cell containing the number 35. A scale bar at the bottom left of the map indicates "500 km".

FOREST MAPPING and MONITORING

Current and future activities

The “next update” of the pan-European forest maps will not be produced by the JRC

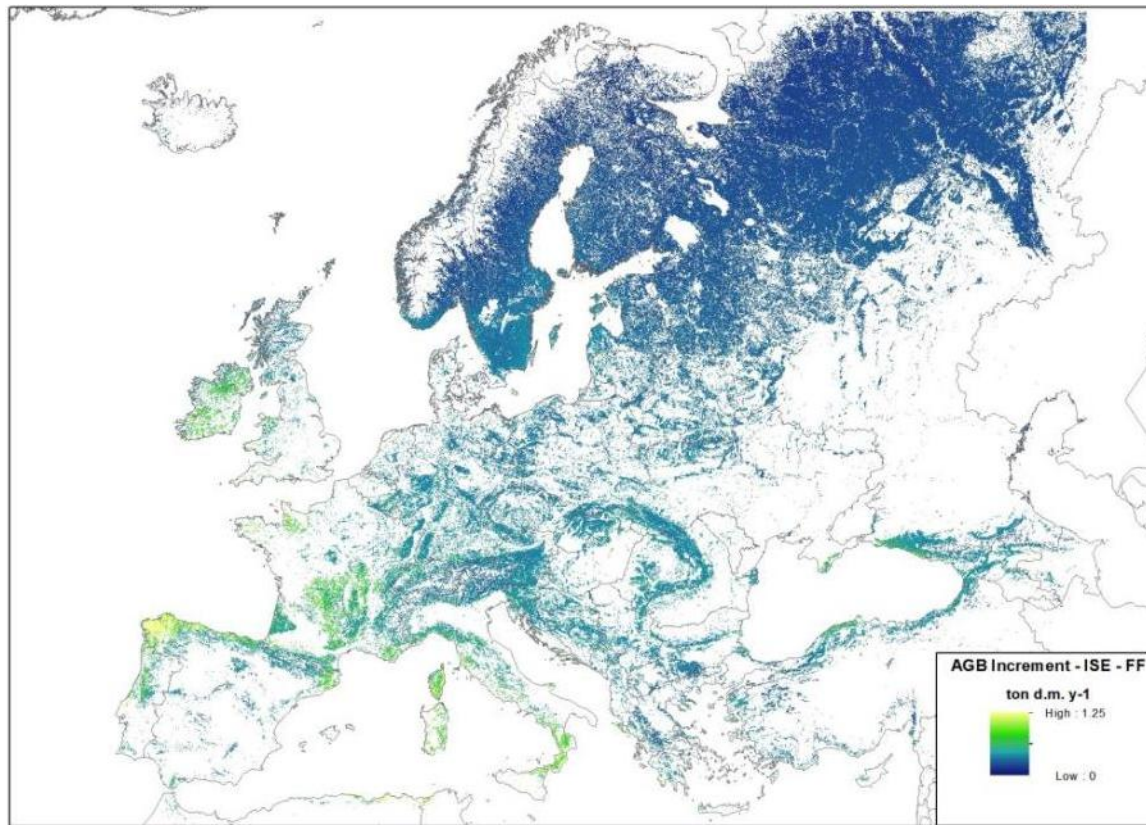
- Produced in the framework of the *Copernicus Land Monitoring Services (Formerly, GIO land)*. Six lots, assigned to different contractors
- Based on IMAGE2012 data (LISS + RapidEye)
- JRC providing support and consultancy

From forest distribution maps to “value-added” products !

- It’s good to know where forests are... but what about their characteristics ?
- The forest mapping group is currently “switching focus” to the production of forest biomass maps, exploiting the available distribution maps, RS data and other information sources

FOREST MAPPING and MONITORING

Current and future activities



**Pan-European Above Ground Woody Biomass Increment map
(provisional)**

FOREST MAPPING and MONITORING

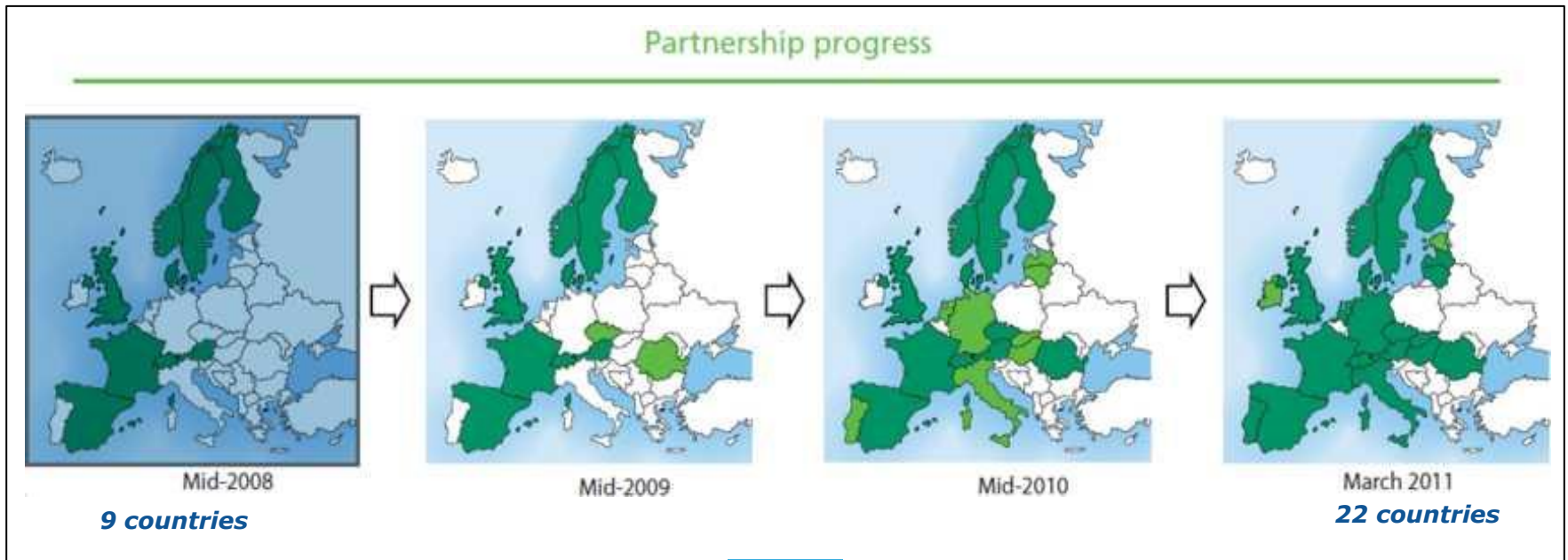
The EFDAC Network

- Mapping and monitoring of Forest characteristics at European level is made difficult by the lack of harmonized ground-reference data !
- 2008-2012: JRC Framework Contract to provide forest data and services to the European Forest Data Centre (EFDAC) through the collaboration with national NFIs

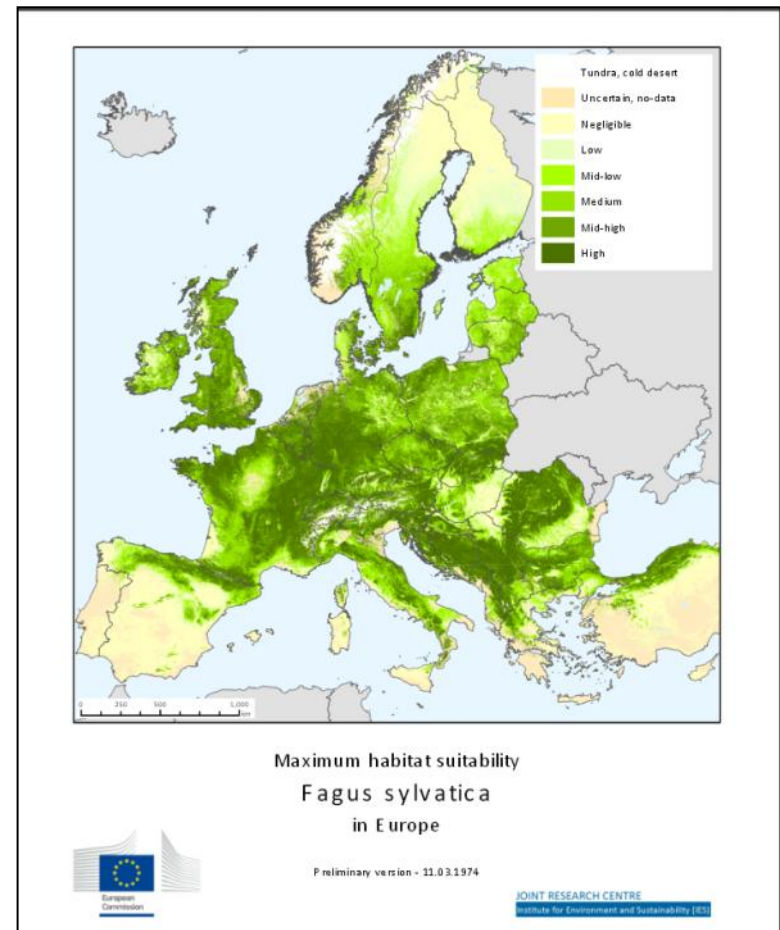
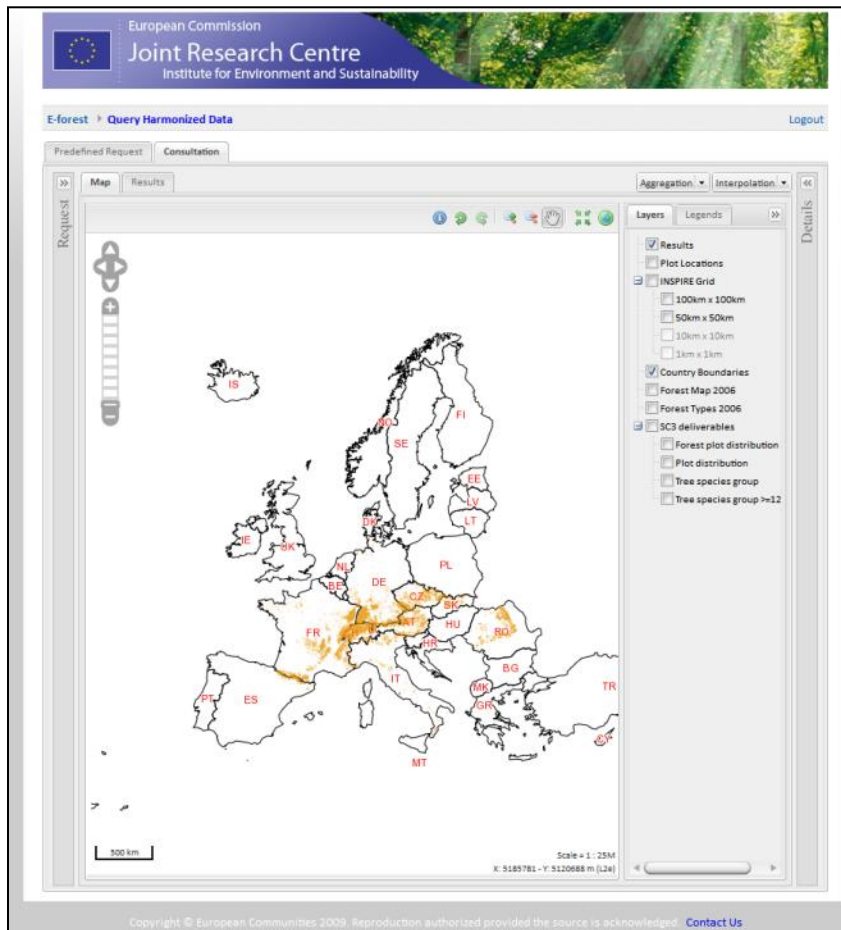
FOREST MAPPING and MONITORING

The EFDAC Network

- NFI Network (E-Forest Consortium) and software infrastructure developed, allowing National Forest Institutes to directly provide(upload) datasets of interest (e.g., species presence/absence; basal area...) for forest modeling, maps validation, etc.
- Data presently used for example for species distribution and habitat suitability modeling



FOREST MAPPING and MONITORING



**Presence of *Fagus Sylvatica* within inventory plots
(Data from NFI E-Forest Consortium)**

Habitat Suitability Map (Present Climate)

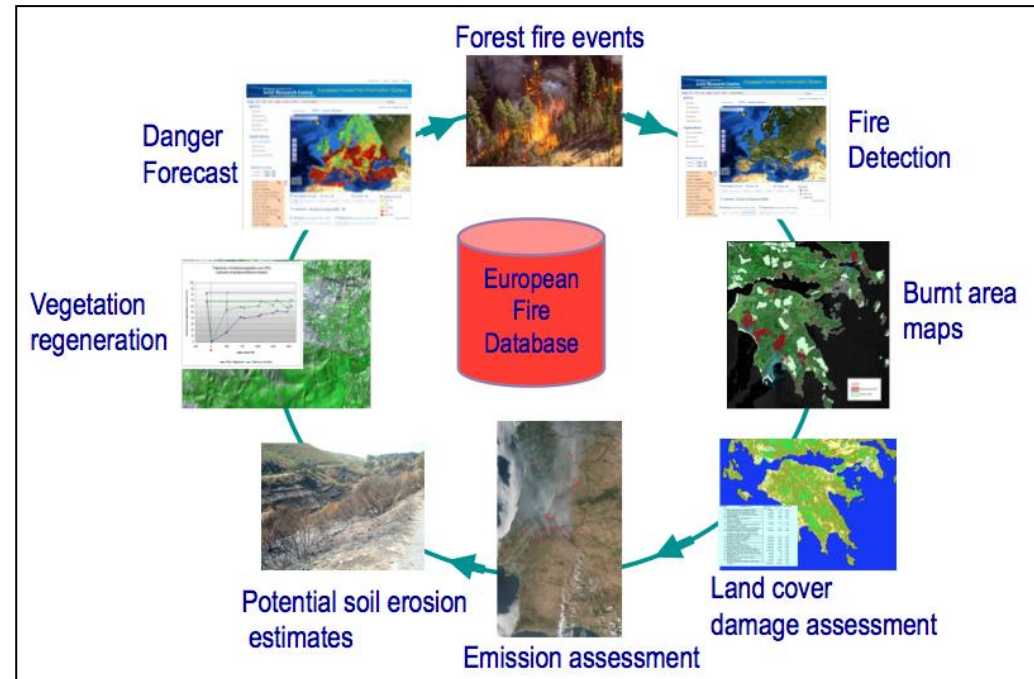
FOREST MAPPING and MONITORING

The EFDAC Network

- 2013-2016 new Framework Contract
- Focus on collecting data for the establishment of new modules in EFDAC towards the development of a Forest Information System for Europe (FISE):
 - ✓ Forest health and vitality, including potential harmful effects to forests from abiotic (e.g. fires, wind storms) and biotic (e.g. pests) agents
 - ✓ Forest resources, including the assessment of carbon balance and adaptation to climate change.
 - ✓ Biodiversity, including green infrastructure and alien species
 - ✓ Biomass production and availability for the "Bio-economy"

FOREST FIRES: EFFIS (European Forest Fires Information System)

- Established in 2000; EC focal point for information on forest fires in Europe
- Provides EU level assessments during both pre-fire and post-fire phases, thus supporting fire prevention, preparedness, fire fighting and post-fire operations
- Complements national fire information systems through the provision of harmonized data, methods and standards

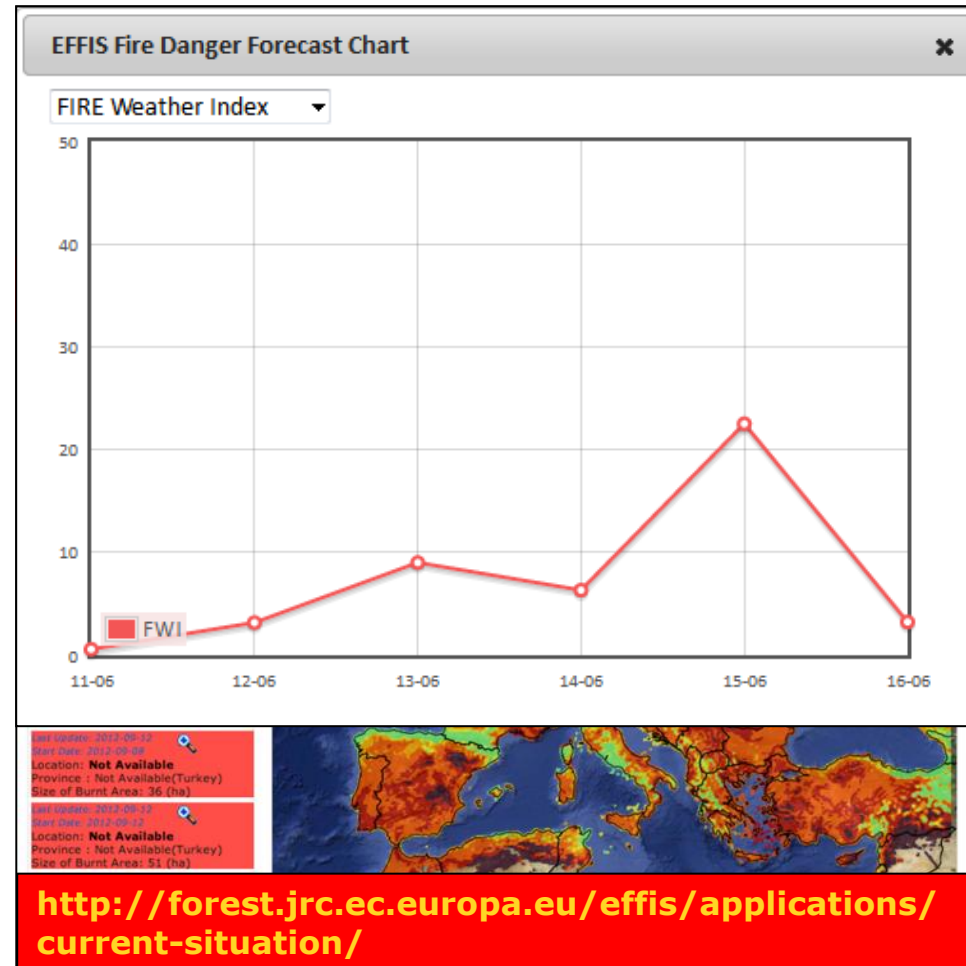


FOREST FIRES MONITORING: EFFIS

Include several sub-modules:

Fire Danger monitoring and Forecasting

- Analysis of fire spread risk, based on meteorological indicators and fuel characteristics (FWI system)
- Forecasts of danger conditions up to 7 days from present (25 Km resolution)

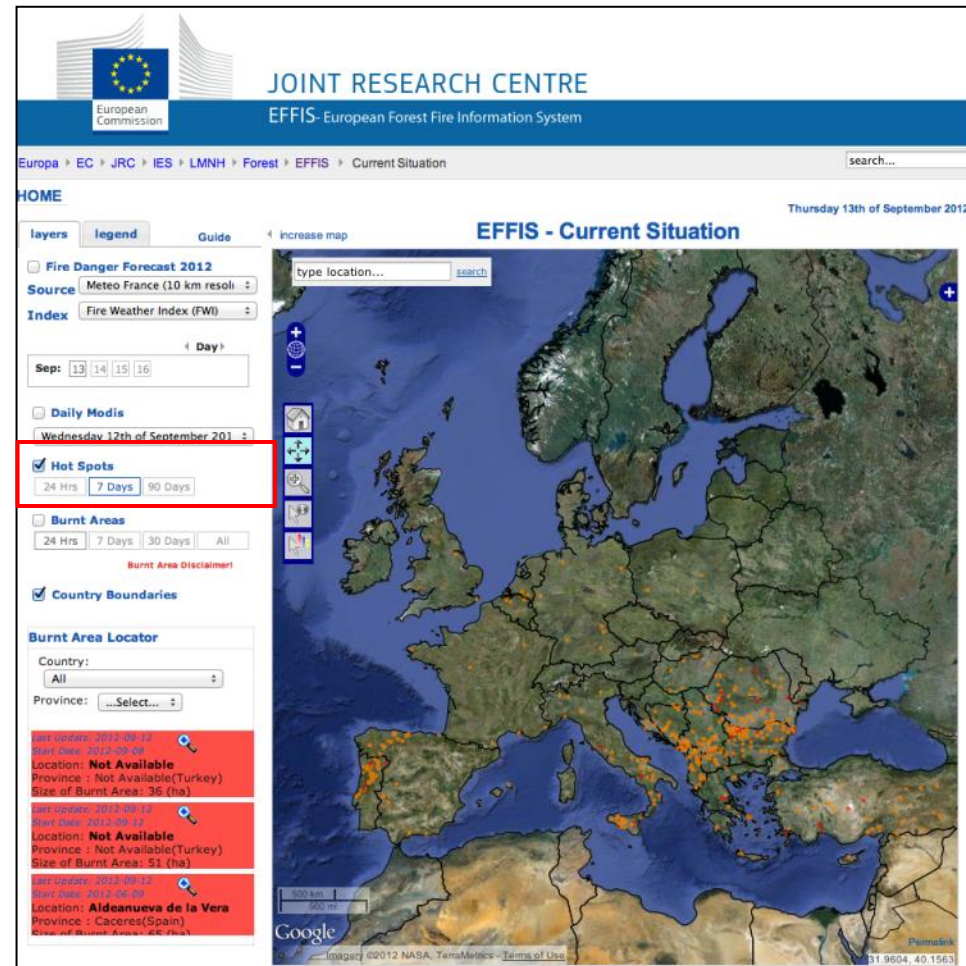


FOREST FIRES MONITORING: EFFIS

Include several modules:

Real-Time Burnt Areas Mapping

- Active fires located by integrating **MODIS hot spots** info...



FOREST FIRES MONITORING: EFFIS

Include several modules:

Real-Time Burnt Areas Mapping

- Active fires located by integrating **MODIS hot spots** info...and **"Fire News"** automatically collected and manually checked



JOINT RESEARCH CENTRE
EFFIS - European Forest Fire Information System

Europa » EC » JRC » IES » FRC » FORESTMOD » EFFIS » Applications » Firenews

EFFIS

- EFFIS
- About EFFIS
- Reports and Publications
- Applications
- Current Situation
- Fire History
- Firenews**
- Geofeeds
- Create a fire
- Data and Services
- Global Viewer (Beta)
- VGI (Beta)

Firenews

Find a location



Search: From: 06/05/2013 To: 06/12/2013

Place	Country	Size	Update	Critical	News
Alanno	Italy	15	June 10, 2013	False	1 News linked
Bocairant	Spain		June 9, 2013	False	1 News linked
Bodrum	Turkey	5	June 6, 2013	False	1 News linked
Bucak	Turkey	12	June 10, 2013	False	2 News linked
Chajelipes, La Gomera	Spain		June 9, 2013	False	1 News linked
Domokos	Greece		June 6, 2013	False	1 News linked
Emponas, Rhodes	Greece		June 9, 2013	False	1 News linked
Estepona	Spain		June 11, 2013	False	1 News linked
Frigiliana	Spain		June 5, 2013	False	1 News linked
Lithaire	France	5	June 8, 2013	False	1 News linked

14 fires selected (with 16 related news). Get this KML

Size Class: - N.A. - Small - Medium - Large - Major

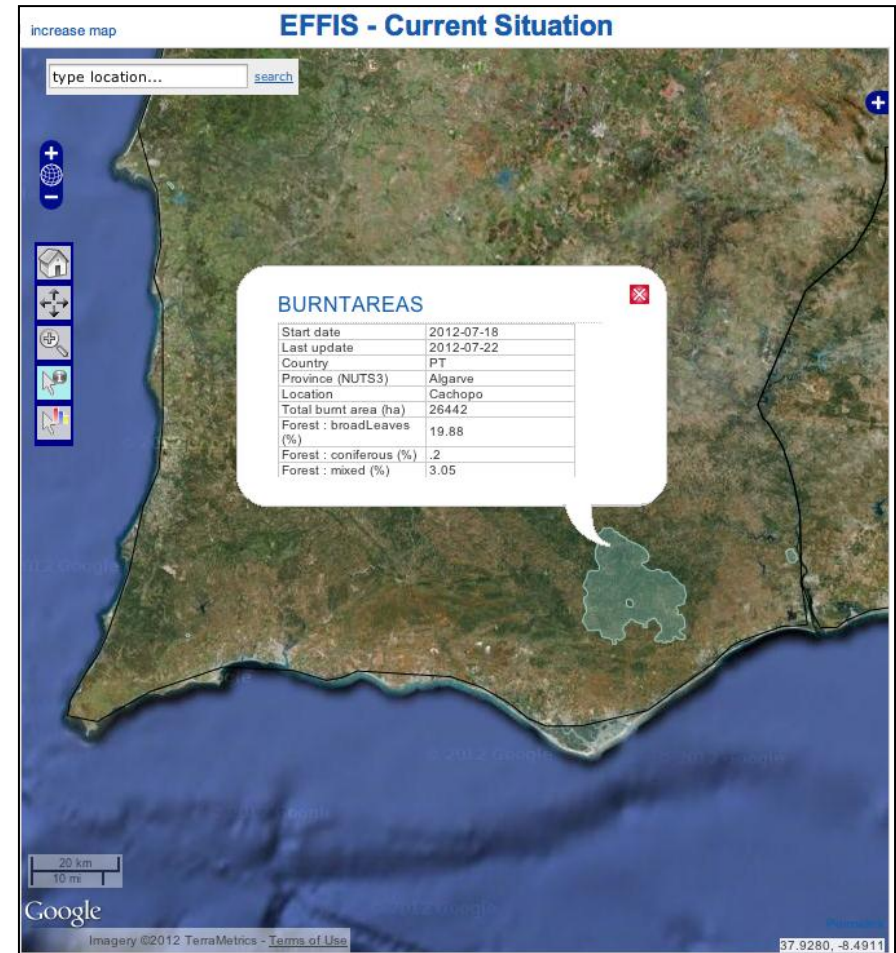
Country: - France - Greece - Italy - Portugal - Spain - Turkey -

FOREST FIRES MONITORING: EFFIS

Include several modules:

Real-Time Burnt Areas Mapping

- Active fires located by integrating **MODIS hot spots** info...and "**Fire News**" automatically collected and manually checked
- Burnt Areas** (>40ha) manually digitized on top of MODIS 250 m satellite images (Daily Update) (Info regarding each identified burnt area stored and provided through the web viewer (start/end date; Burnt Area; Affected land cover; etc.)
- Identified fires account for about 75% of total yearly burnt area in Europe



FOREST FIRES MONITORING: EFFIS

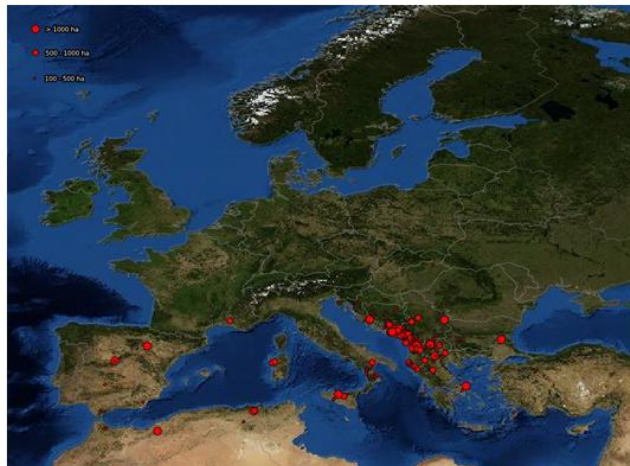
Weekly reporting on fire activity in Europe

Weekly report on forest fire activity in Europe and the Mediterranean area

24-08-2012 - 30-08-2012

The map below shows the location of main forest fire events mapped by EFFIS during the last 7 days.

Only fires > 100 hectares are shown at this scale. Dot size is according to the extent class of the fire event.



The full list of fires mapped by EFFIS in the last 7 days is in the following pages.

For each fire, the following information is given: **Date of last update**, **Location (province)**, **Burned area (ha)**.

Notes on the fire list:

Fires are grouped by country and are sorted by decreasing size within each country.
Fires with burned area larger than 500 ha are highlighted in bold.

European Union

Bulgaria

- 2012-08-27: Slivovo Burgas **1744 (ha)**
- 2012-08-29: Kireevo Vidin **1674 (ha)**
- 2012-08-27: Rilski manastir Kyustendil 246 (ha)
- 2012-08-28: Dolna banya Sofia 118 (ha)

France

- 2012-08-27: Eyguieres Bouches-du-Rhone **775 (ha)**
- 2012-08-27: Borne Ardeche 33 (ha)

Greece

- 2012-08-29: Dimos Aylonos Evvoia **3724 (ha)**
- 2012-08-27: Dimos Kalampakas Trikala **692 (ha)**
- 2012-08-30: Dimos Melitis Florina **658 (ha)**
- 2012-08-29: Dimos Kyrroy Pella 426 (ha)
- 2012-08-28: Dimos Melitis Florina 389 (ha)
- 2012-08-25: Koinotita Afidnon Attiki 327 (ha)
- 2012-08-29: Dimos Kamelroy Dodekanisos 302 (ha)
- 2012-08-24: Dimos Elation Zakynthos 242 (ha)
- 2012-08-29: Dimos Askioy Kozani 151 (ha)
- 2012-08-25: Dimos Paravolas Aitolokakamania 74 (ha)
- 2012-08-28: Dimos Lagana Zakynthos 54 (ha)
- 2012-08-27: Dimos Nemeas Korinthia 35 (ha)
- 2012-08-29: Dimos Moysoyron Chania 17 (ha)

Italy

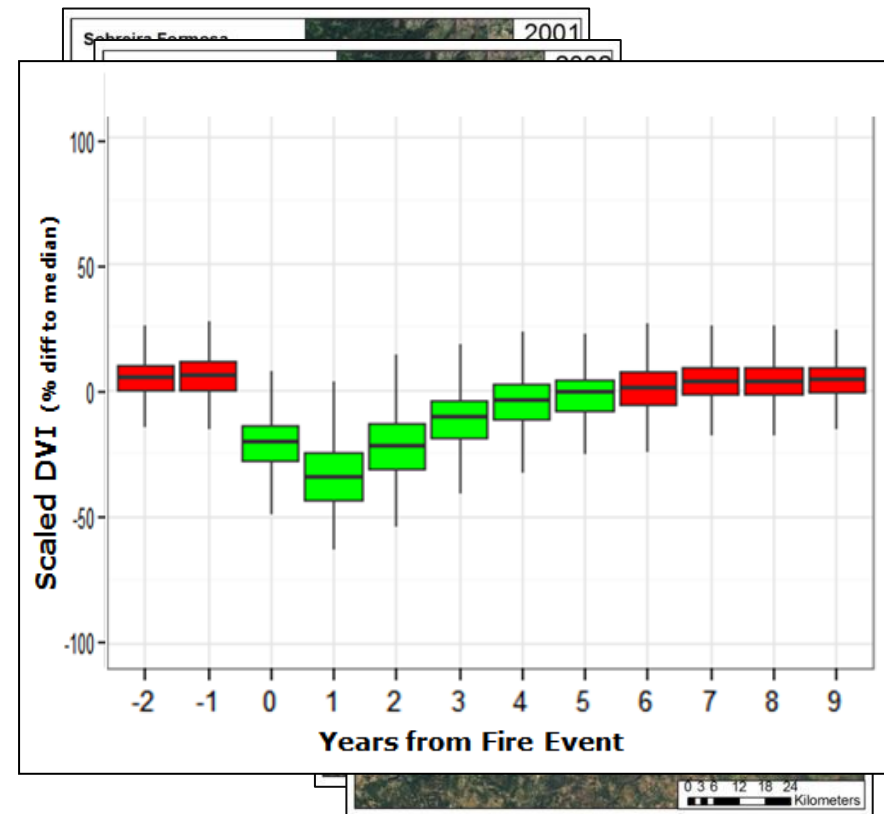
- 2012-08-26: Sclafani Bagni Palermo **1294 (ha)**
- 2012-08-28: Risticci Matera **784 (ha)**

FOREST FIRES MONITORING: EFFIS

Include several modules:

Post Fire Regeneration Monitoring

- Based on analysis of time series of MODIS 250m vegetation indexes (end of summer data)
- Allows to monitor the post-fire regeneration dynamics

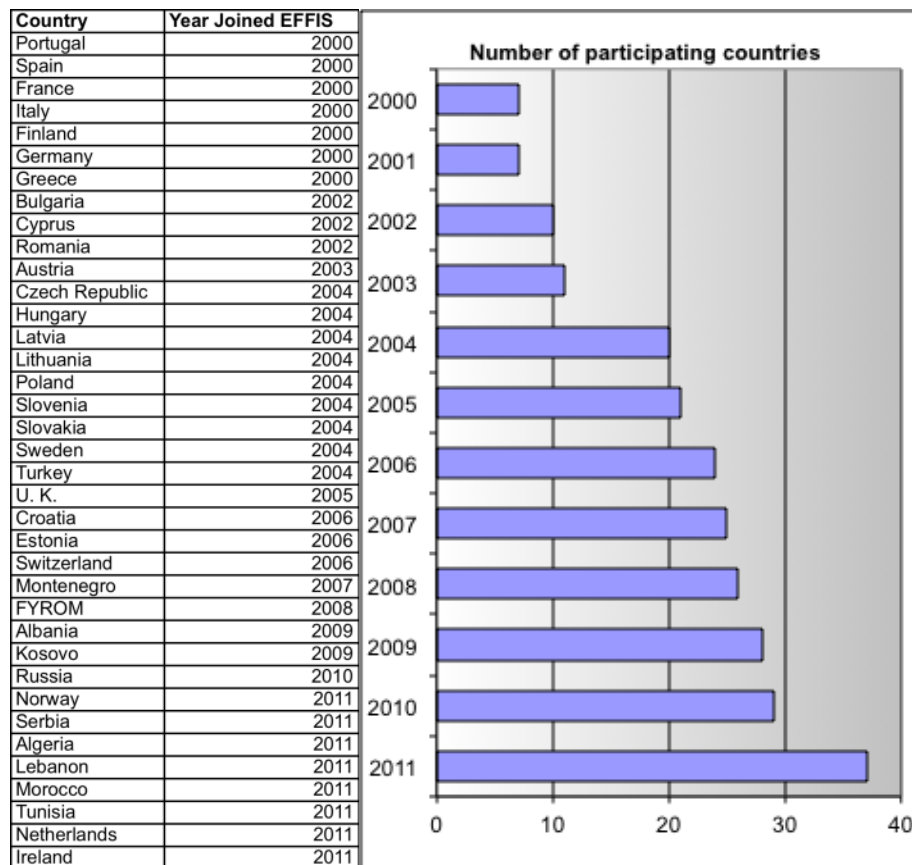


FOREST FIRES MONITORING: EFFIS

- Other modules (at various stages of development):
 - **Fire Severity Assessment...**
 - **Fire Emissions Assessment...**
 - **Seasonal forecasting (weather anomalies)...**
 - **Fire smoke dispersion...**
 - **Fire spread...**

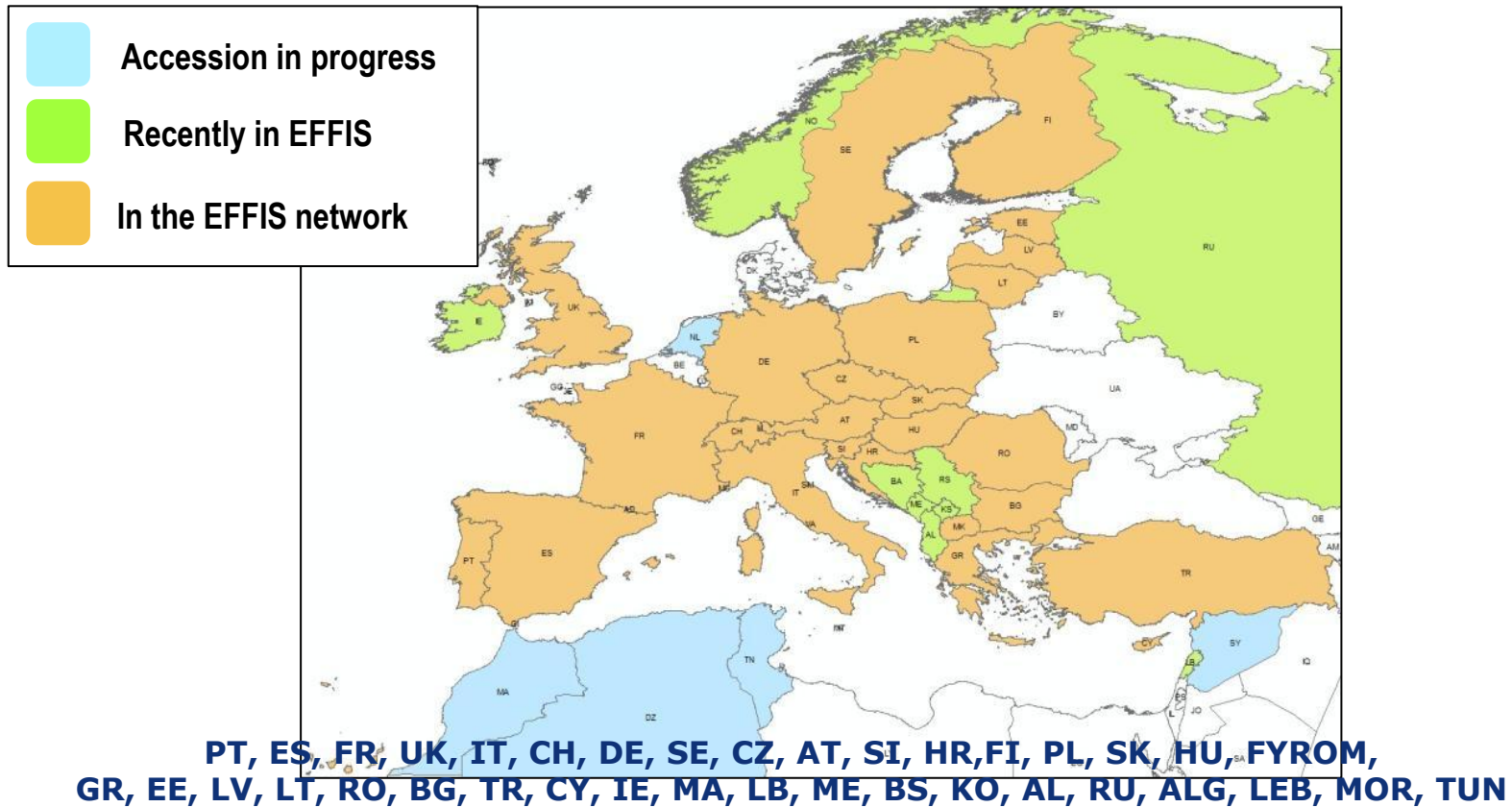
FOREST FIRES MONITORING: The EFFIS Network

- Network of countries involved in the exploitation and further development of EFFIS



FOREST FIRES MONITORING: The EFFIS Network

- Network of countries participating in the exploitation and further development of EFFIS



FOREST FIRES MONITORING: The EFFIS Network

EFFIS Fire Database

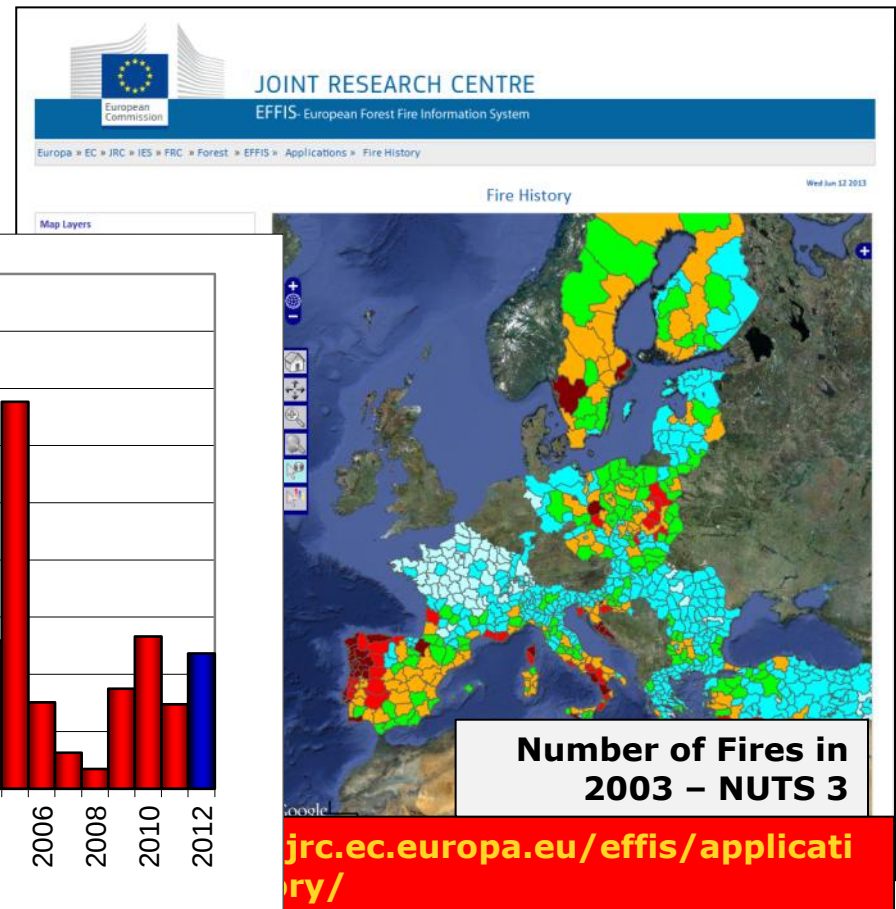
EFFIS members are both benefiting from EFFIS, and providing it data !

ID	Unique Fire identifier	FIREID
TIME OF FIRE	Date of first alert [YYYYMMDD]	DATEAL
	Time of first alert [HHMM]	TIMEAL
	Date of first intervention [YYYYMMDD]	DATEIN
	Time of first intervention [HHMM]	TIMEIN
	Date of fire extinction [YYYYMMDD]	DATEEX
	Time of fire extinction [HHMM]	TIMEEX
LOCATION OF FIRE	Province Code (national nomenclature)	PROVCODE
	NUTS3 code	NUTS3
	Commune Code (national nomenclature)	CODECOM
	Commune Name (national nomenclature)	NAMECOM
	Latitude [decimal degrees]	NORTH
	Longitude [decimal degrees]	EAST
SIZE OF FIRE	Burned Area FOREST [Ha]	BAFOR
	Burned Area OTHER WOODED LAND [Ha]	BAOW
	Burned Area OTHER NON WOODED NATURAL LAND [Ha]	BAONW
	Burned Area AGRICULTURE AND OTHER ARTIFICIAL LAND [Ha]	BAAGR
CAUSE OF FIRE	Presumed Cause (EU categories code)	CAUSE_EU
	Presumed Cause (Country detailed categories code)	CAUSE_CO

FOREST FIRES MONITORING: The EFFIS Network

EFFIS Fire Database

- Allows to analyze characteristics and temporal trends of burnt areas in Europe

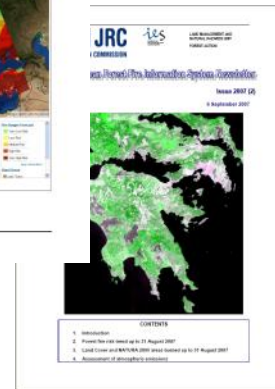


European
Commission

J R C T E C H N I C A L R E P O R T S

**Forest Fires in Europe,
Middle East and North Africa
2011**

Joint report of JRC and
Directorate-General
Environment



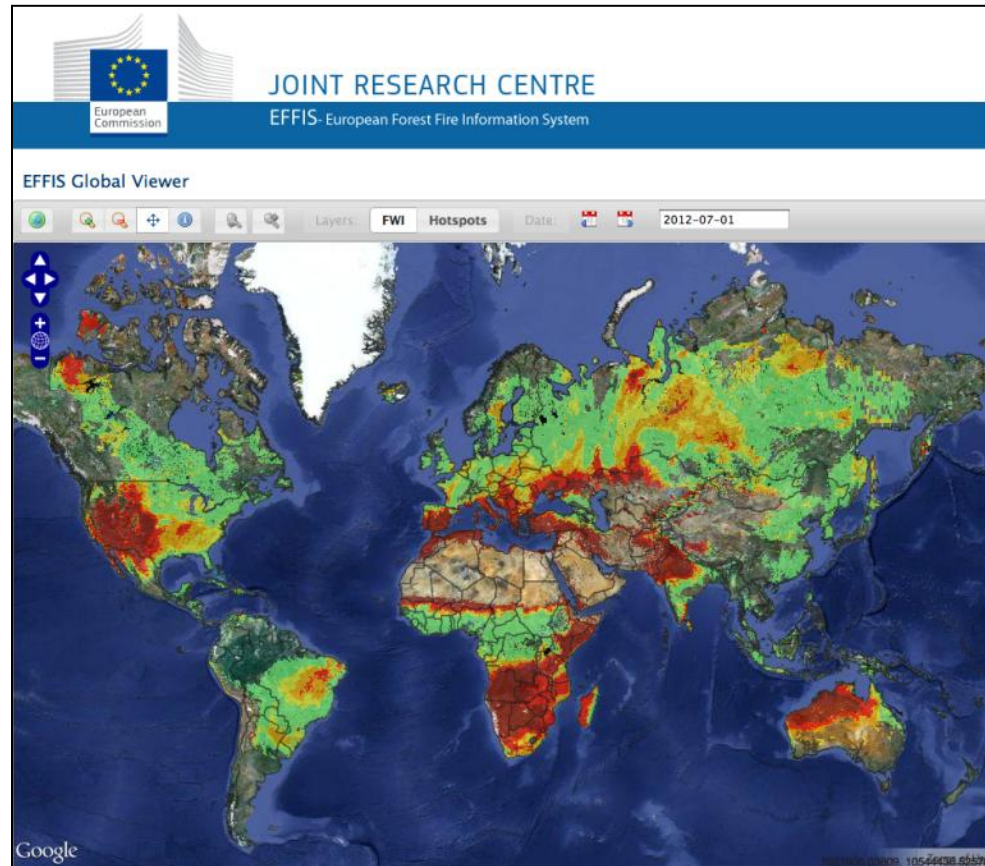
FOREST FIRES MONITORING: EFFIS

Report on forest fires in Europe up to October, 2012

- Average **burnt area** in the EU in the last 12 years approx. **470,000 ha/yr.**
- Estimated **annual losses** in the last 12 years approx. **2 billion/year**
- 2012 fire campaign:
 - Early fire activity due to drought in the EU Med region (approximately 100,000 ha burnt by the end of March)
 - Spring fire activity in central Europe (e.g. fire in Hungary approx. 1000 ha)
 - Damages area above average of last decades (approx. 567,000 ha)
 - Large impact in Natura2000 areas (approx. 180,000 ha)
 - Considerable number of human casualties

EFFIS – Extension to a Global Fire Information System

(beta system in partnership with the GOFC Fire IT, supporting GEOSS)



Thanks for your attention !

effis@jrc.ec.europa.eu

efdac@jrc.ec.europa.eu

Global Wildfire Information System (beta)

Fire Danger Assessment

Single Model Deterministic Components up to 10 days

ARPEGE
res. 10 km
European

DWD LAM
res. 7 km
European

DWD NWP
res. 25 km
European

EC HIRES
res. 16 km
Global

EPS Control
res. 32 km
Global

Probabilistic (Ensemble) Components up to 15 days

EPS Ensemble Mean
res. 32 km - Global

FWI Probabilities for
critical thresholds
res. 32 km - Global

Probabilities for Extreme
Values of FWI (>50)
res. 32 km - Global

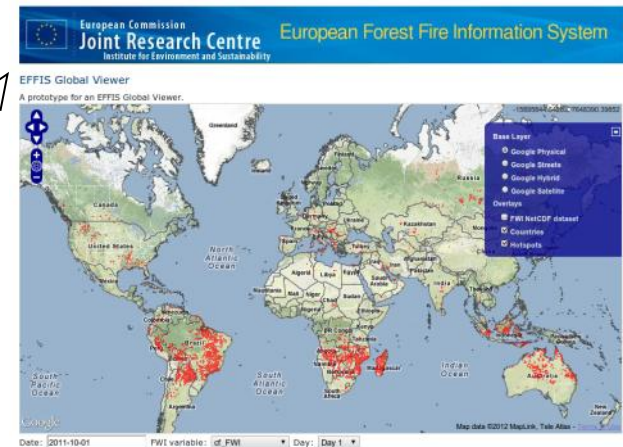
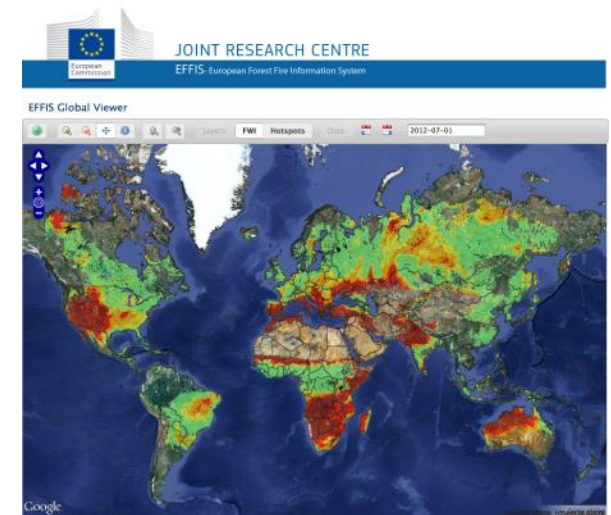
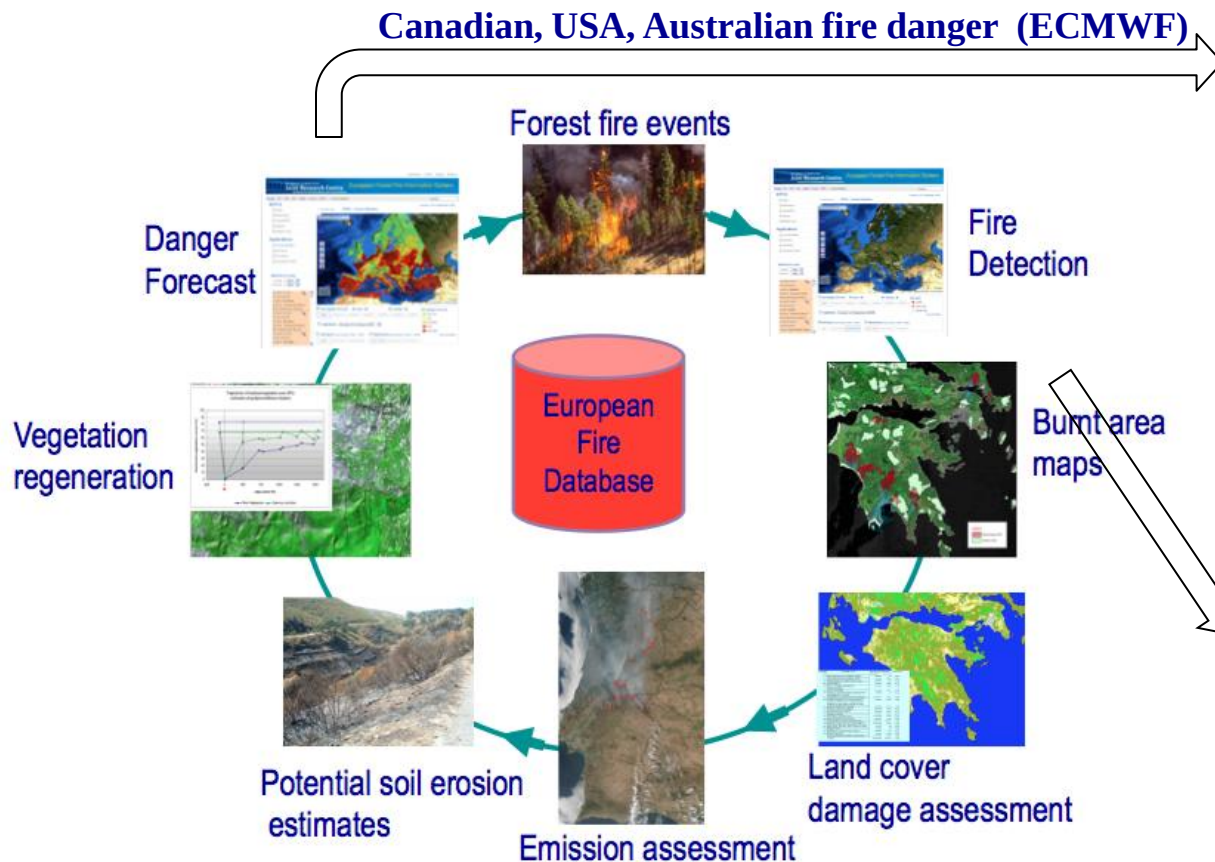
Additional Monthly & Seasonal Products up to 4 months

Weekly Anomalies of Temperature
& Precipitation from
Monthly Forecast System

Seasonal Anomalies of
Temperature & Precipitation

EFFIS – Extension to a Global Fire Information System

(beta system in partnership with the GOFC Fire IT, supporting GEOSS)



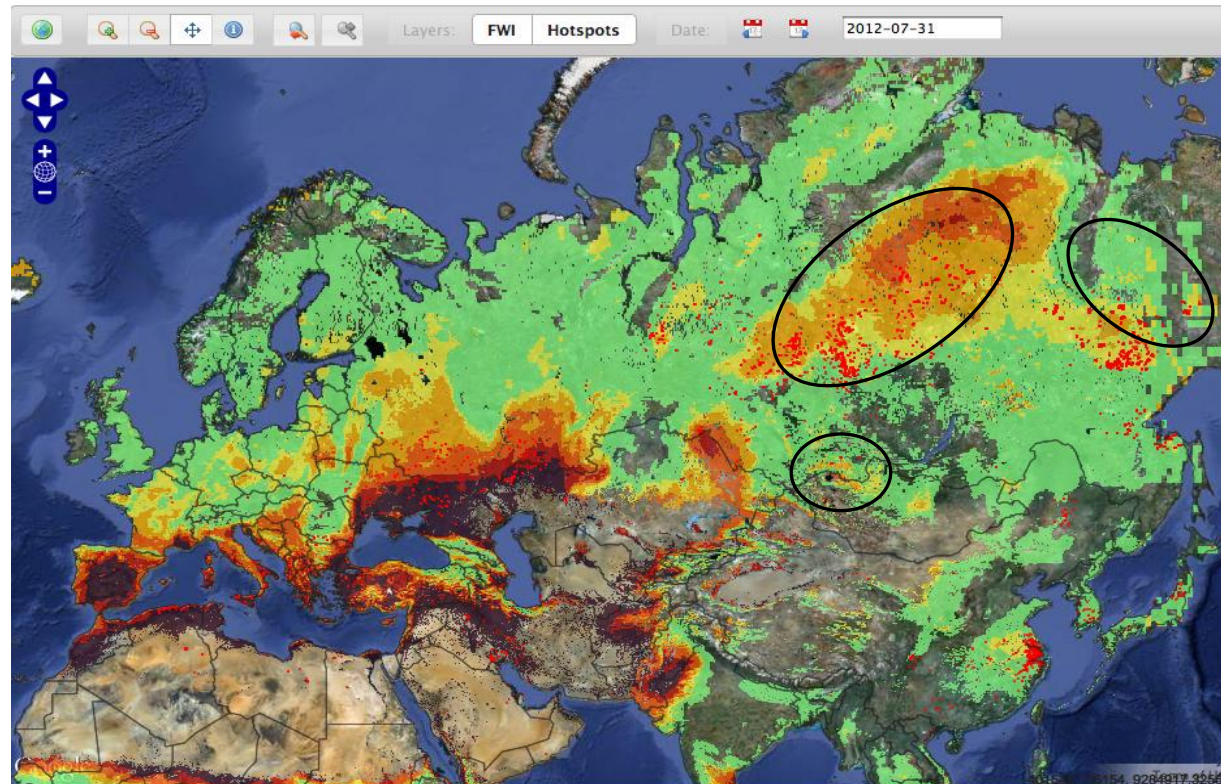
Global Wildfire Information System (prototype)

Fire activity in Russia – July 31, 2012

JOINT RESEARCH CENTRE

EFFIS- European Forest Fire Information System

EFFIS Global Viewer



Assessment of fire severity

