Early detection, surveillance of wildfires and the integration into fire management systems

System Forest Ranger

Presentation by Joachim F. Dreibach

Aarau, Switzerland

Forest Ranger

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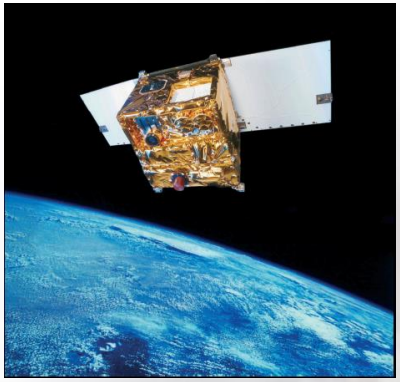
Detection Methods

Photo by: Lookout Charles White

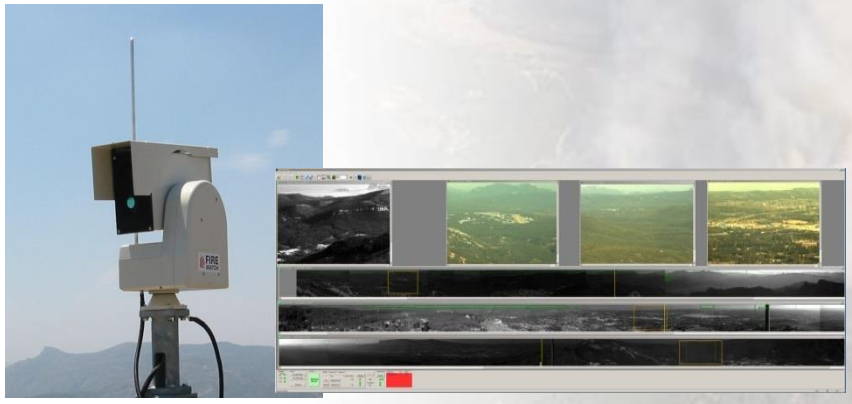
Aircraft Surveillance (Ontario)



Satellite (Modis)

UAV (California)

Video Sensor (Pelco)



Forest Ranger (Sensor and Control Office)

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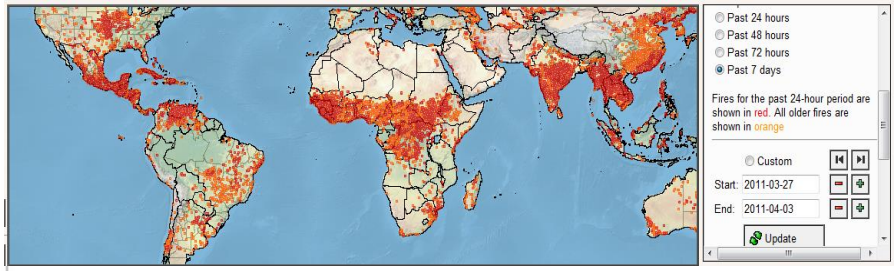
Aspects for detection - integrated into Fire Management

Economical Aspects



■ Russia » Economics

Forest Fires Cause Damage of $15 Billion to Russian Economy

10.08.2010

Environmental Aspects

Up to 56 million hectares of land are destroyed by wildfires each year in Asia, according to FAO.
Since 1970 wildfires have caused an estimated US$11.6 billion in economic damage in Asia, according to the World Health Organization's (WHO) International Disaster Database EM-DAT.

Human Health Aspects

Particles from smoke tend to be very small, with a size range near the wavelength of visible light (0.4 – 0.7 micrometers), and are therefore nearly completely within the fine particle (PM2.5) fraction. Thus, smoke particles efficiently scatter light and reduce visibility. Moreover, such small particles can be inhaled into the deepest recesses of the lung and may represent a greater health concern than larger particles.

North Coast Unified Air Quality
Management District
2300 Myrtle Avenue, Eureka, CA 95501
Telephone (707) 443-3093 FAX (707) 443-3099
http://www.ncuaqmd.org

Air Quality Alert Issued
7-20-08 10:30AM

For the following areas:
Humboldt County: Willow Creek and all areas proximal to the wildfires.
Trinity County: Burnt Ranch, Junction City, Helena, Big Bar, Big Flat, Weaverville, Covington Mill, Hayfork, Hyampom, Mad River, Zenia, and all areas near the wildfires.

Smoke levels in these areas have been classified as VERY UNHEALTHY. Individuals in these areas should follow all health protective guidelines for smoke conditions, including limiting activity and staying indoors. Please see the guidelines listed on the general Public Service Announcement issued today.

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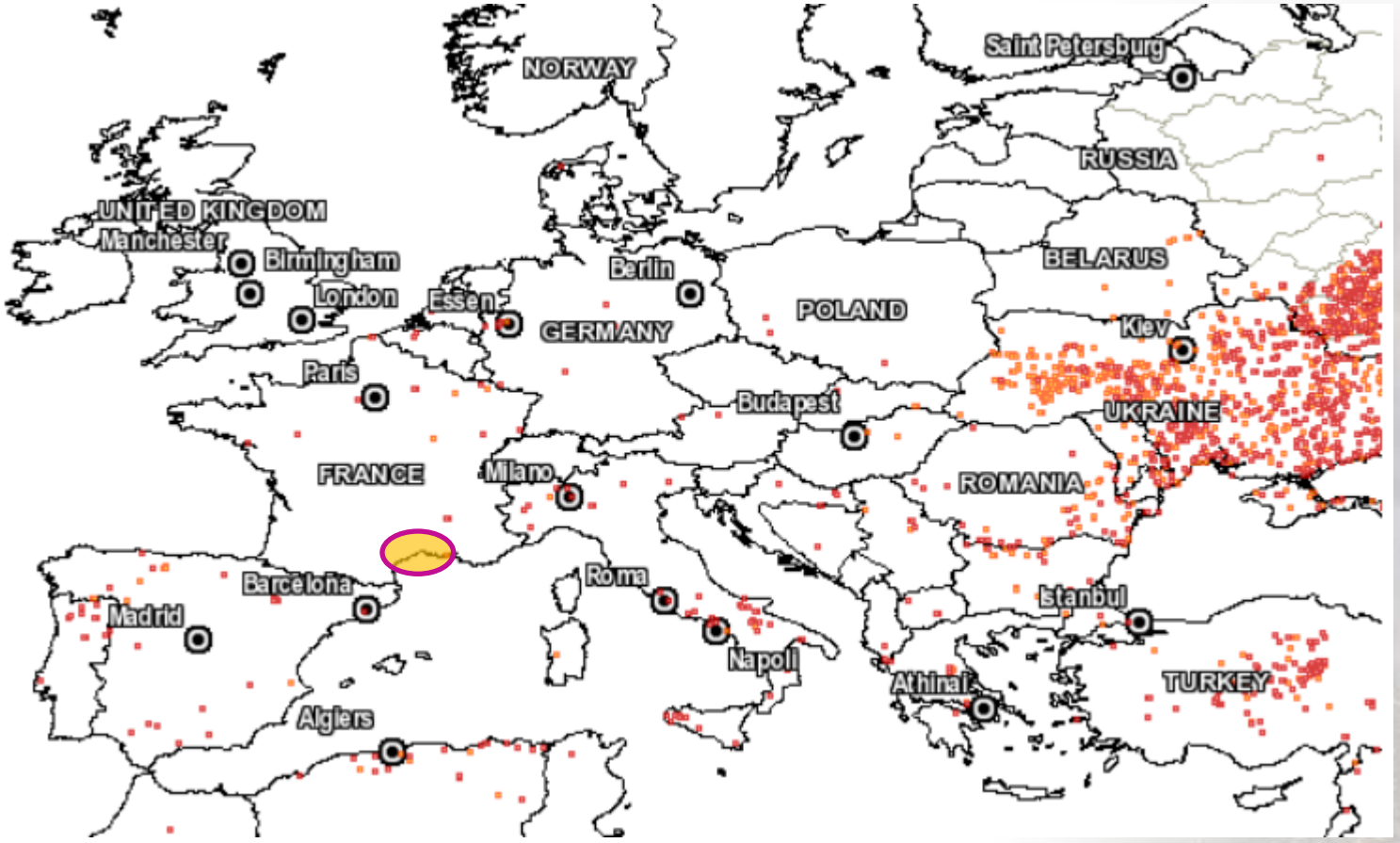
Example Fire Situation August 2012



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Figures example spain

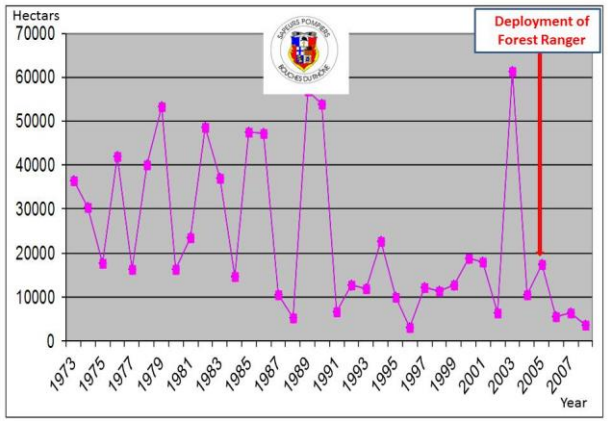
24 big fires in 2012
135 000 ha surface
2/3 of this are protectable areas (high value)

Burned Surface 3x higher than Year before

(info WWF2012)

Costs per damaged ha: 4125EUR (info Proplanta)

Figures example France



Increasing fire danger and fire risk
Increasing number of fires

Annual Burned surface 3x less than before – long term evaluation

(info French center of Research and Experience)

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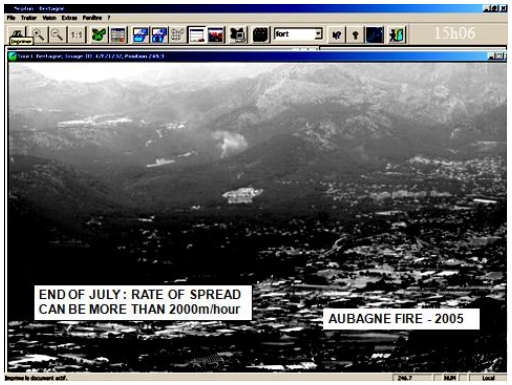
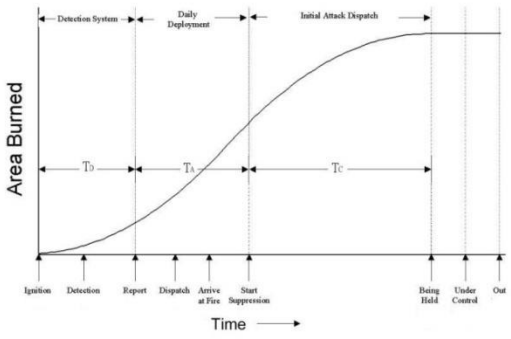
Key points identified to mitigate the impact of forest fires at France

- **Early detection of fire fighting**
  - Detecting the fire ignition
  - Precise localization of the fire
  - Evaluating potential strength of the fire
  - Determining the resources best adapted for the situation
  - Determining priorities in the case of multiple fires
- Executing a massive attack against emerging fires
  - Engagement of aerial resources on any emerging fire, prioritizing over fires already underway
  - Engagement of adapted land vehicles and in large numbers
- Organization of firefighting operations
  - Operational procedures
  - Daily adaptation of equipment and resources according to the risks
  - Personnel training
- Improving the vehicles for ground firefighting
  - Increasing water capacity of trucks, developing canons to attack from a distance, developing new extinguishing techniques
  - Usage of land retardant
- Improving aerial firefighting vehicles
  - More highly capable aircraft: taking in more water
  - Developing aerial fighting techniques against night fires

Specification drivers for early detection

- Fast starting fires
- Day and night fires
- Fast moving fires
- Fast changing weather /environmental conditions
- Difficult topography (hills, mountains ….)
- No mains power available
- Fast detection, meeting initial attack requirements (< 20 minutes response)
- Provide much more functionalities and data, than only detect a fire





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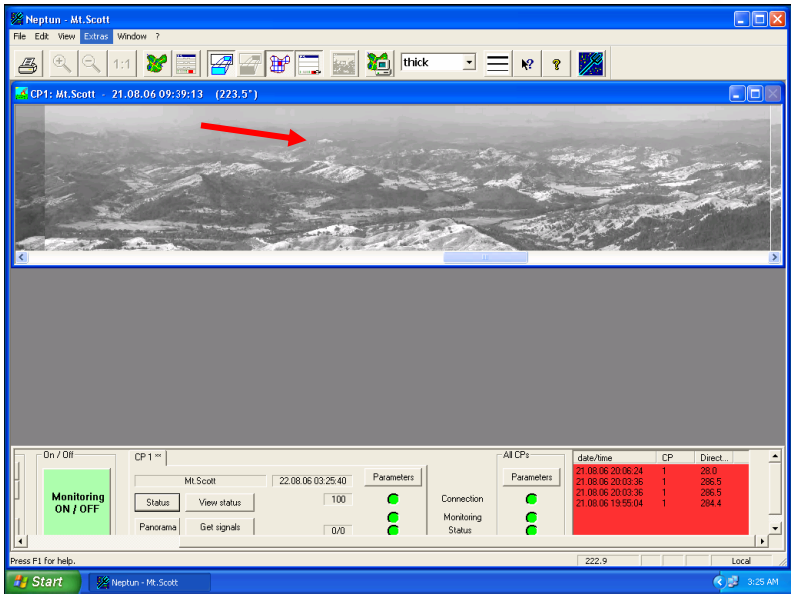
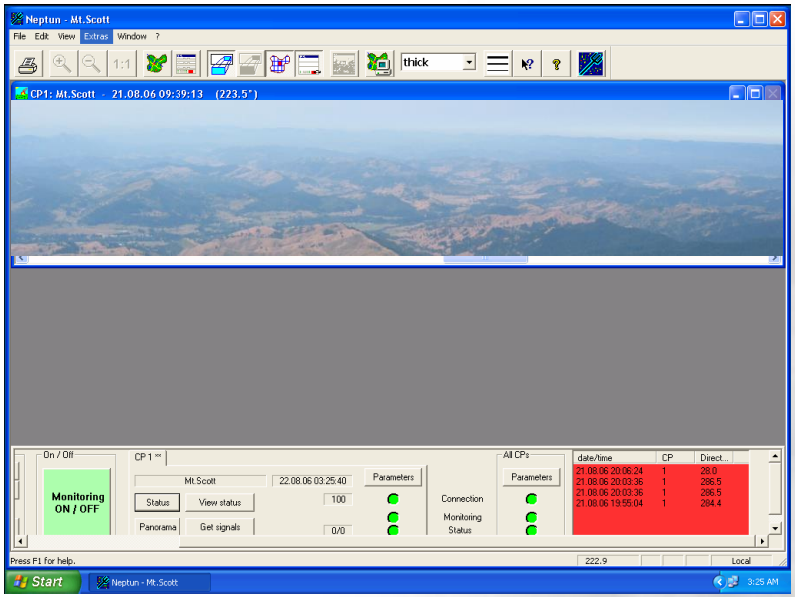
Automated Smoke Detection





Control Office Forest Ranger Sensor

Forest Ranger detected a fire in 35 mile's distance.

Identification by eyes on the panorama image

monitor an area of 5000 km^2 (40 km radius)

Control Office Video Sensor

No identification possible,

high UV level limits range

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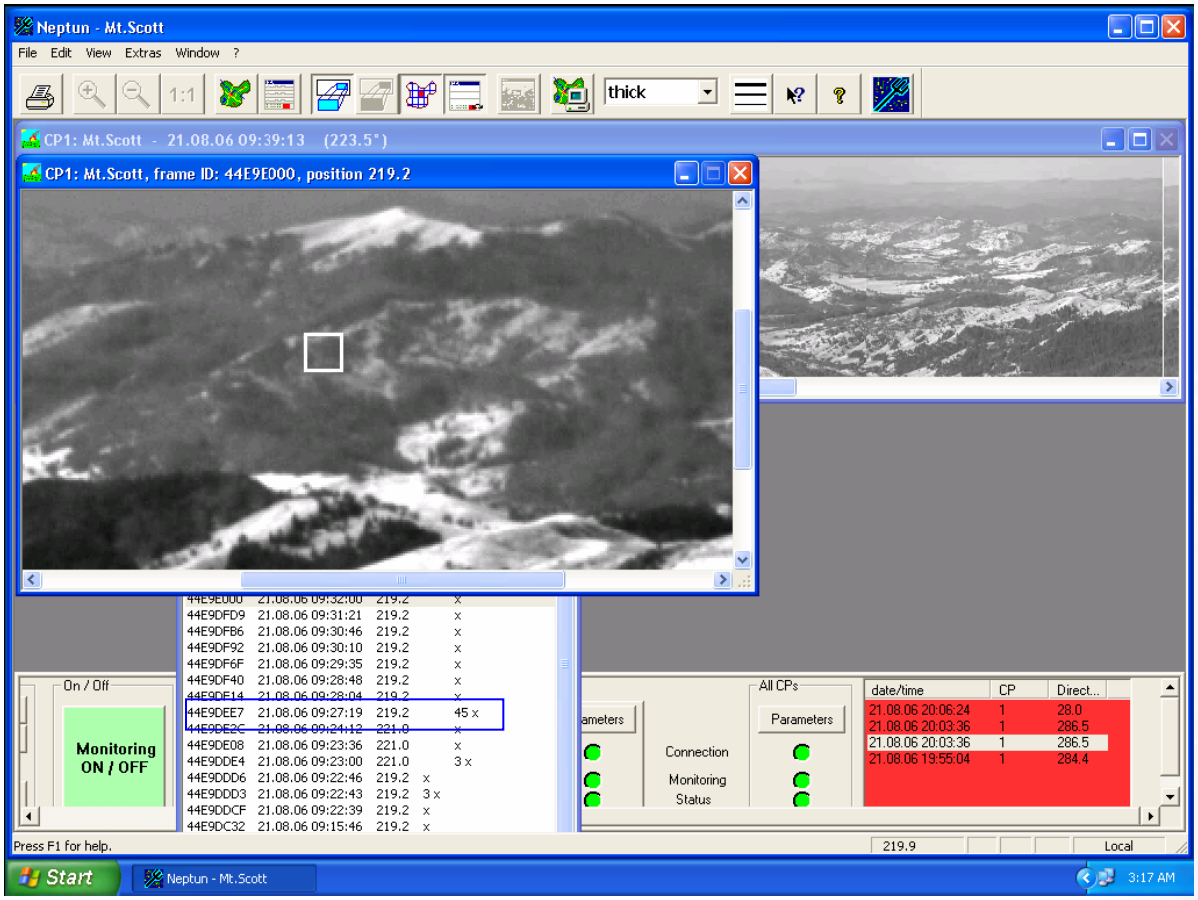
Automated Smoke Detection



Zoomed image:

Fire was identified as a Barbeque fire .

monitored with 45images (23 minutes) as recorded in the database.

Clear verification, that did not expand in size and structure during the time of observation.

Verified distance:

34miles from the sensor position

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Forest Ranger – Analysis Parameter

Analysis	Parameter	+interactive value
Contrast	>10% to Background	+ Geographic reference
Color	12000steps in colour range	+ grey value Overlay
Dynamic	Move of pixels	+ Wind information
Expansion	Extending of effected pixel area	+ Wind direction
Geography	Map	+ 3D Simulation

This analyze disturbing effects, not related to a fire and reduce the alert rate.

Average Alert rate of apr.20 - 50 Alerts/Tower/day (Alert Rates with Video Systems is 150-500).

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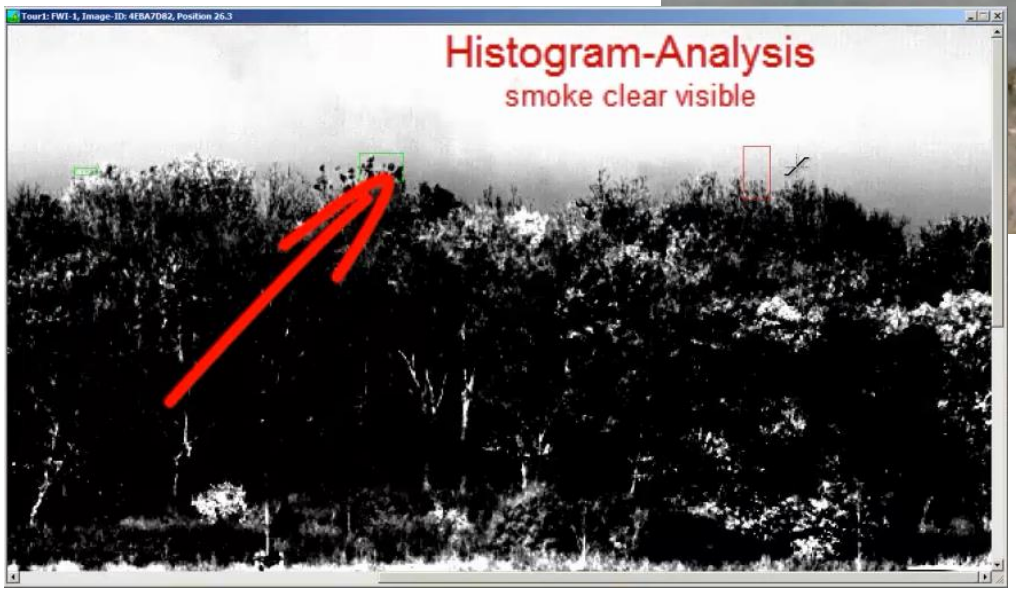
Video – versus detection system



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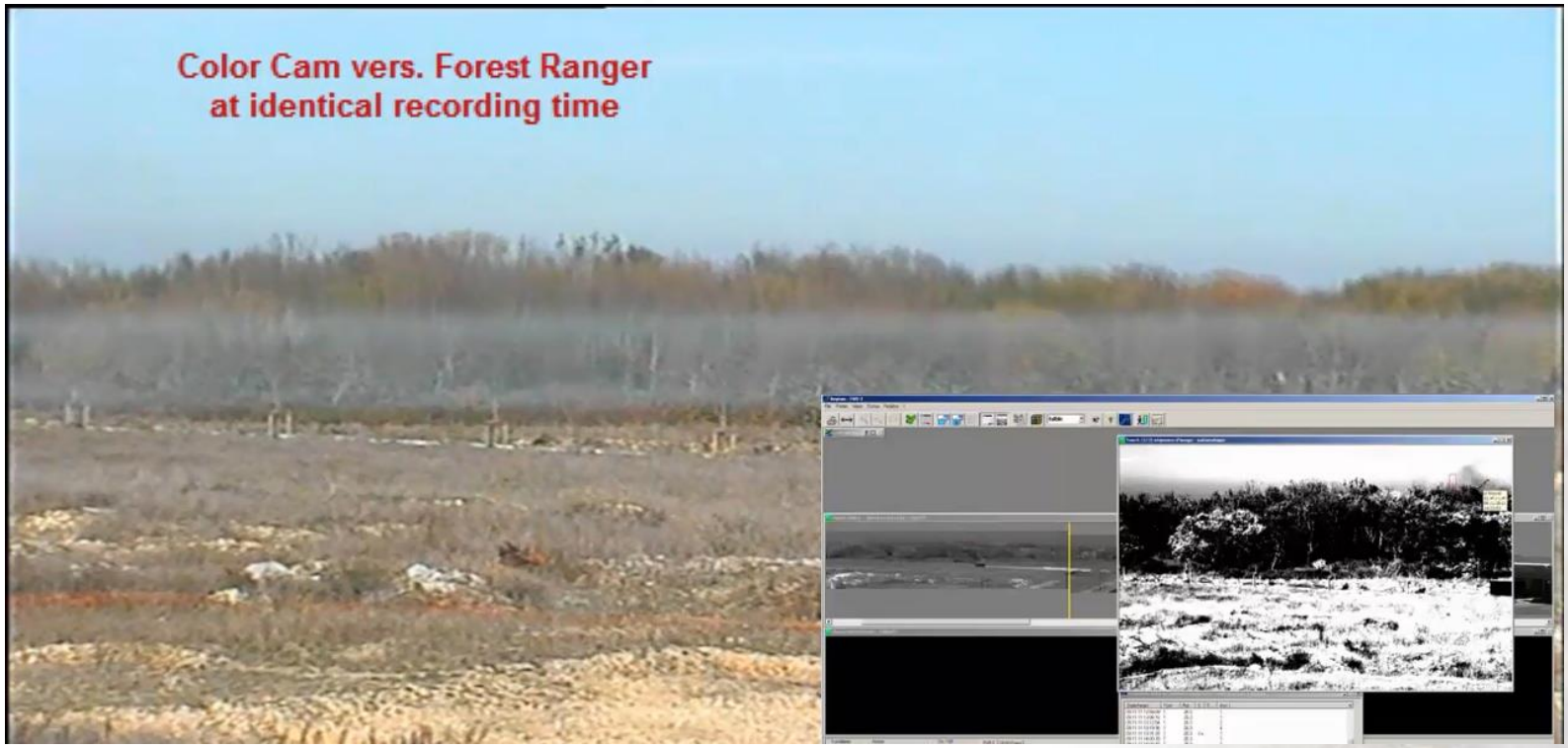
Video – versus detection system



Fire ignition was 21 minutes before this screenshot

- Clear smoke identification on Forest Ranger analyzed image (histogram) ,
- no smoke visible in video image

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Forest Ranger – Image Analysis

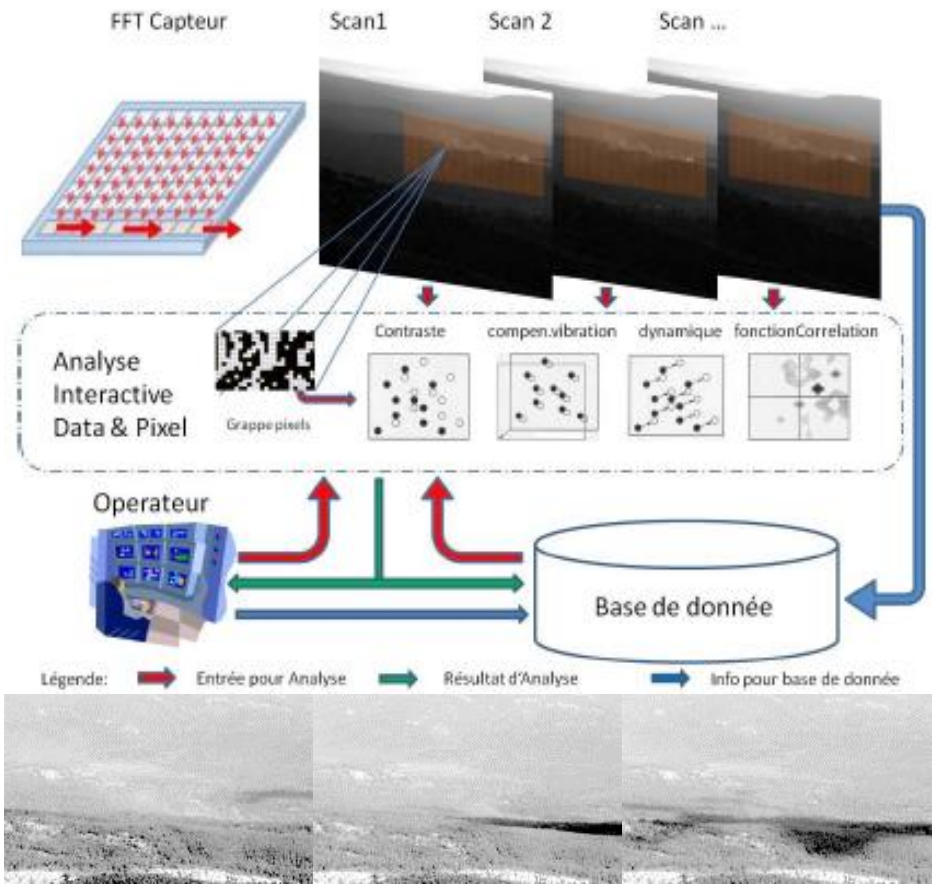

image processing pixel by pixel identify the portions of images corresponding to the smoke criteria like

- **colour**
- **contrast**
- **dynamics**
- **expansion, and**
- **brightness**

utilizing data and parameters from the interactive database.

The portions identified on the three images are then processed in order to analyse any variation in the targeted portions.

If the system construes it as smoke emanating from a fire, it sends an alarm signal to the control office.

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Automated Smoke Detection – Surveillance Requirements

Smoke is one of the first visible signs of a starting fire ..

= smoke is the preferred detection parameter

Factors in the observed areas, not correlated to smoke plume shall largely eliminated

Additional information like:

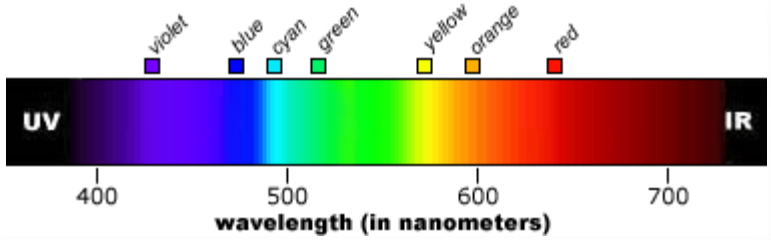
- coordinates of a fire (multiple format – GPS, Lambert II, WGS84..)
- distance from the fire and
- information about the type and the size of a fire

Another important information for the fire fighter strategy:

- color and visible structure of the smoke plume

Analysis of a wide spectrum of light:

visible range (400-700nm) during daylight ⇨ near IR for night detection



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Automated Smoke Detection – Disturbing Factors

Disturbance factors – mostly dynamic:

- **Moving objects -** like cars, animals, people, aircraft, clouds, shadows, air turbulences,
- **Fixed objects -** with changing interferences like trees moving in the wind, sun reflections on various objects.
- **Visual effects -** like fog or smog which camouflage the smoke plume in long distances

These factors demonstrate, that an automated smoke detection requires more than commonly used video system and image processing software to guarantee a reliable analysis at a minimum of false alerts.
Under these aspects, the limitation of video systems become obvious.

- Detection in this spectrum range may show best performance with a **filtered color channel**
- Color images for the smoke classification and monitoring requires a **color sensor**

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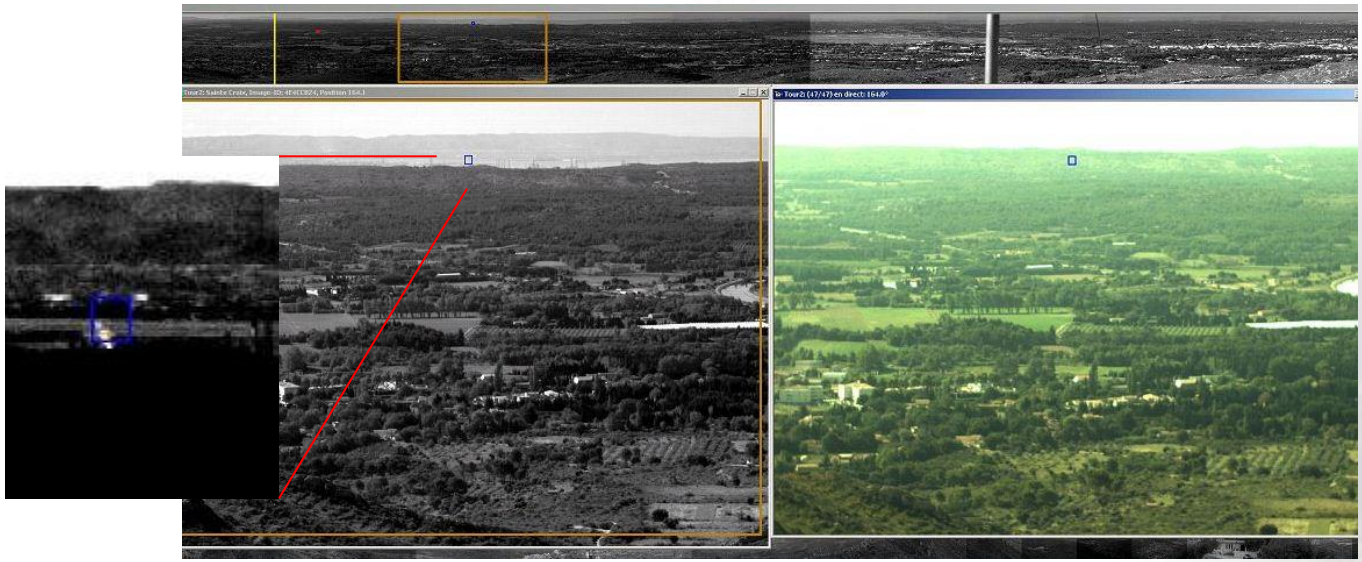
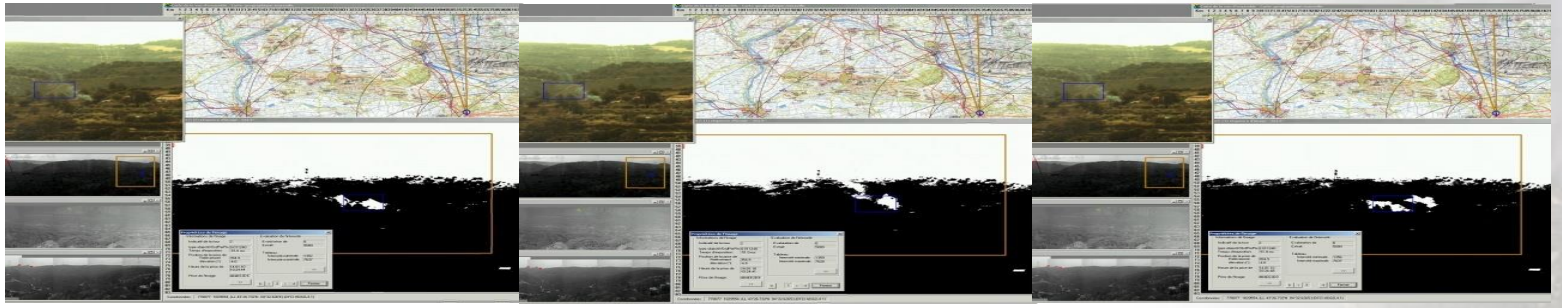
Forest Ranger – Operator tools





Operator alert verification by histogram analysis

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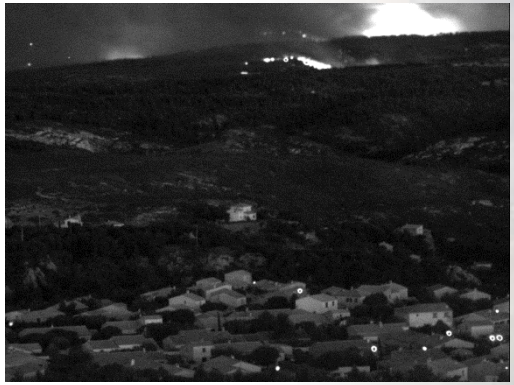
Forest Ranger Day & night reliable detection and data acquisition



Examples for night detection

all alerted between 1 a.m. - 5 a.m.

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Demands for Fire Management integration

- Color- and/ or B/W sensing for detection
- Black & White images for smoke identification
- Color Information for smoke classification and monitoring
- Day and night visual information
- Weather / environmental information
- Geographical / topographical information (hills, mountains, slopes, POI)
- Position information (geo-referenced coordinates)
- Sensor status information
- Interactive sensor access for request of dedicated real time data by authorized users
- Database for event analysis- and training tasks

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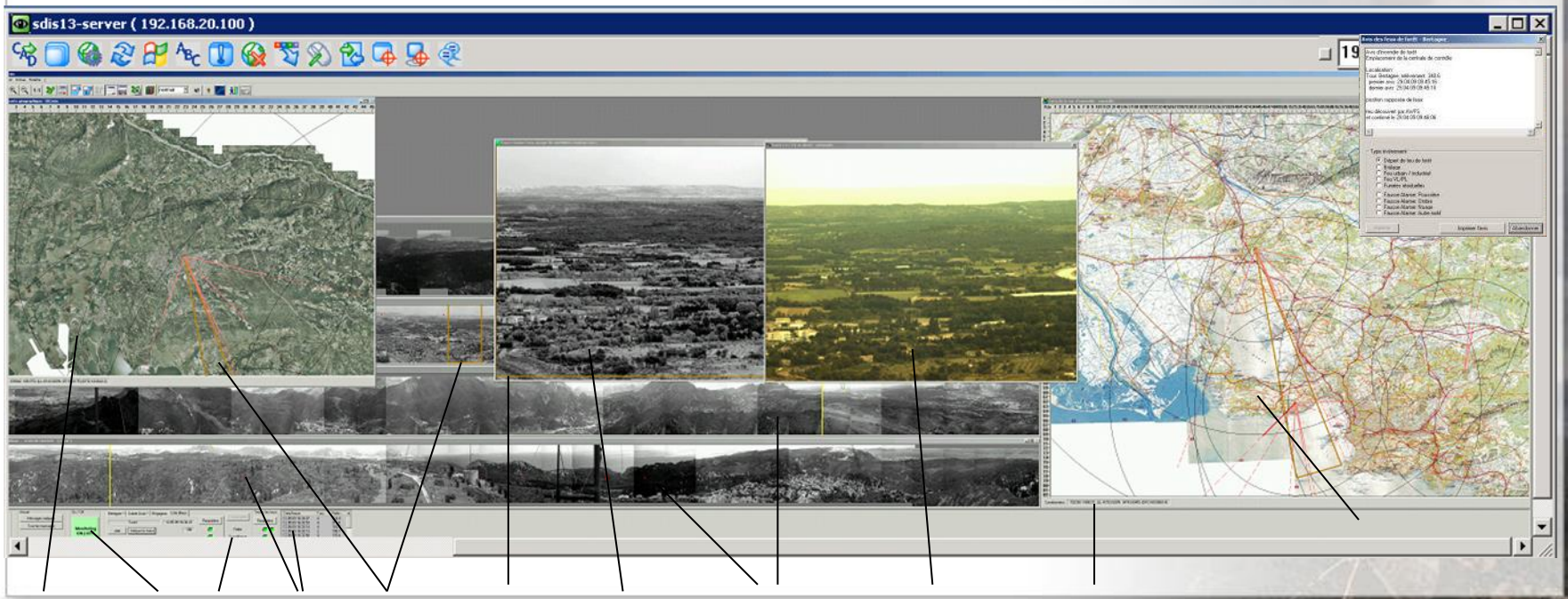
Forest Ranger - Alarm Information

Utilizing such procedures, we provide a powerful tool to supply an array of goal oriented information to the operator.

In this way, the reliability and utility are proven and will be the base for a cost effective, economical investment to the customer.



Areal Photo - System Status - Alerts - Sector live sequence - b/ w image - Panorama view - color live seq. – Coordinates (WGS,LL,DCFI)- Digital Map

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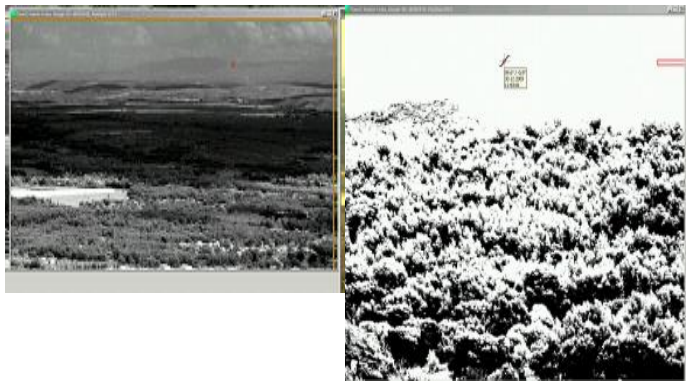
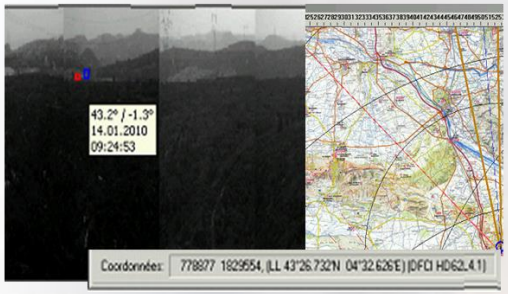
Alert Information summary

Visual image b/w with analysis functions

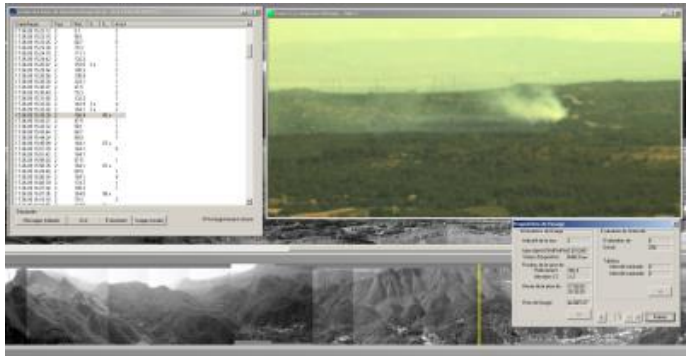


Numeric - , visual - and localization-information

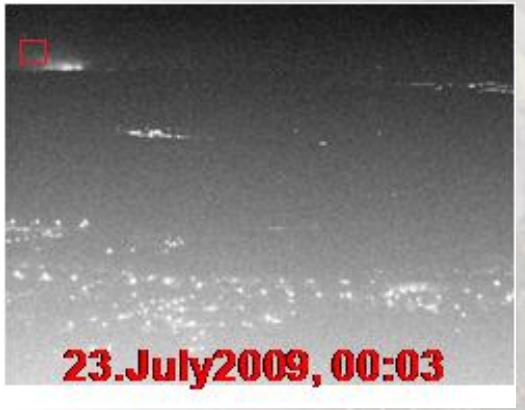
Date/heure	Tour	Relèv...
14.01.10 09:17:55	2	79.5
14.01.10 09:12:42	4	143.1
14.01.10 09:12:03	2	130.0



Color - & incident information (Live monitoring & database)



Night detection



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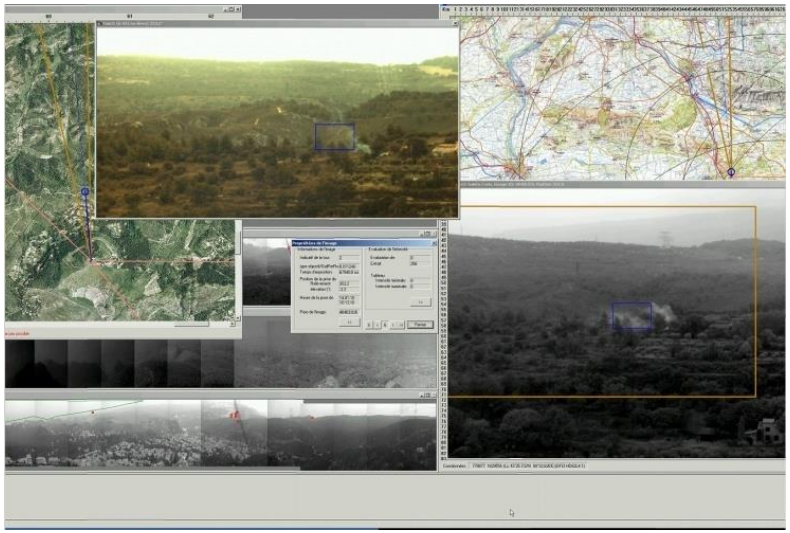
Data provided for Fire Management

Color, image, parameter and database information



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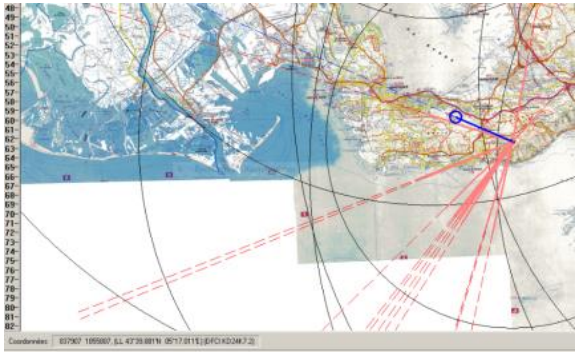
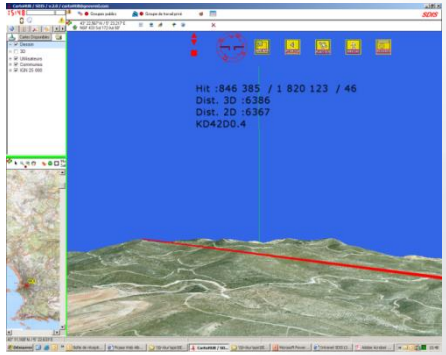
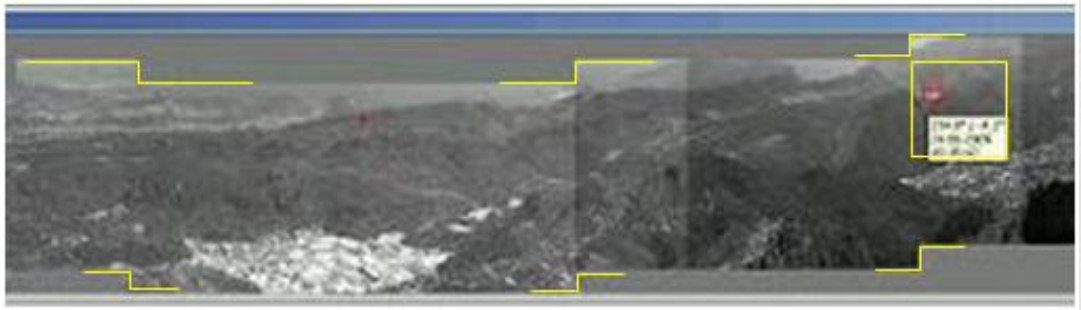
Data provided for Fire Management

Geographic localisation





Geo-referenced information
(true azimuth & elevation related to sector and coordinates)



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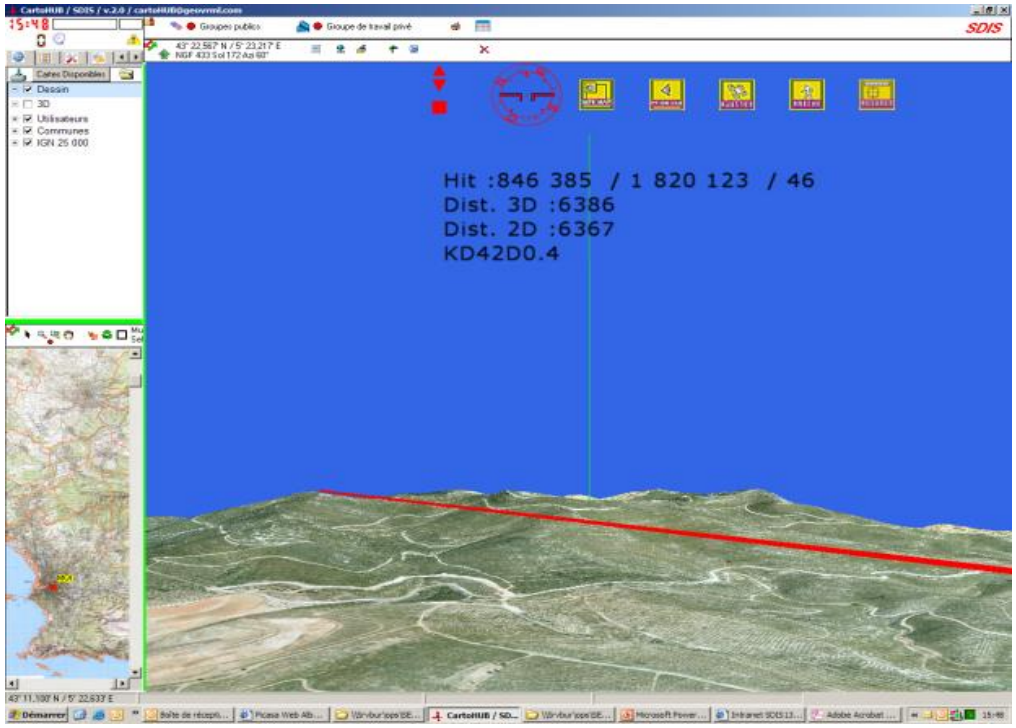
Forest Ranger – Fire Management Tools

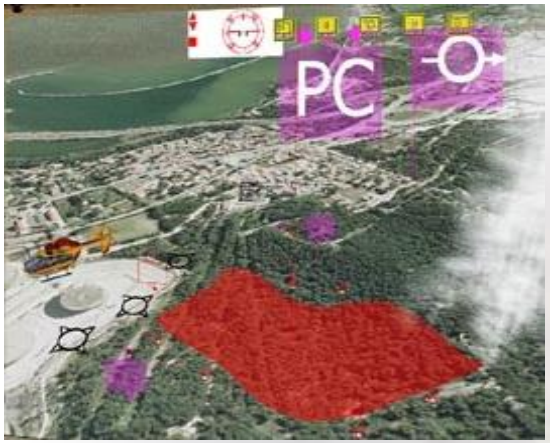
Fire evaluation by live monitoring (apr. 25-30 km)

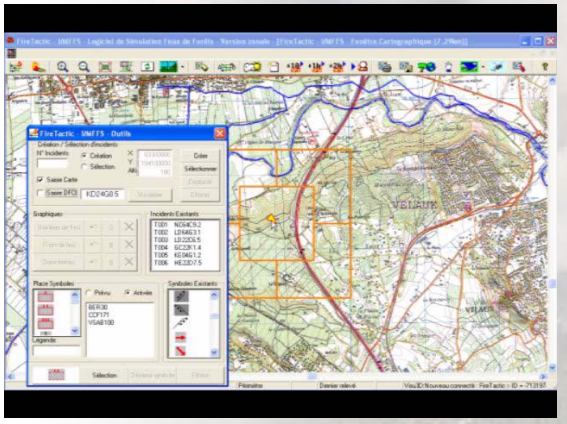
Fire Management Tools

2D/3D Position simulation:

Network integration for
2D/3D Simulation of fire position
and fire behavior simulation







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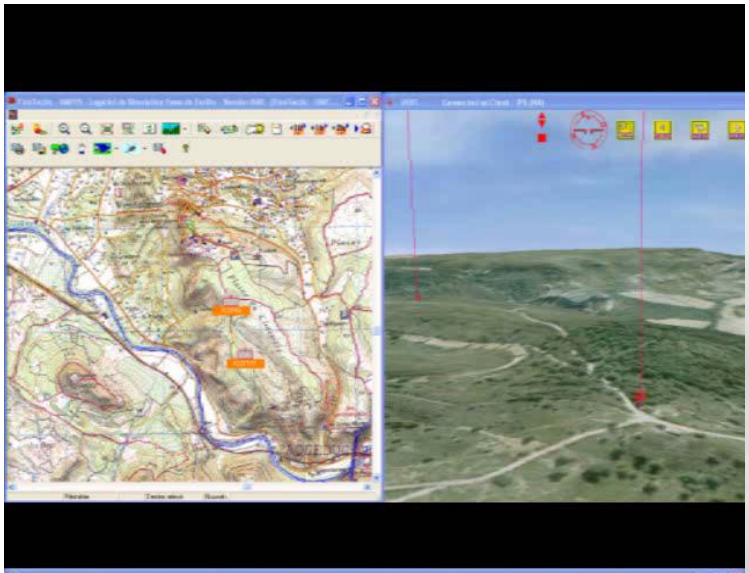
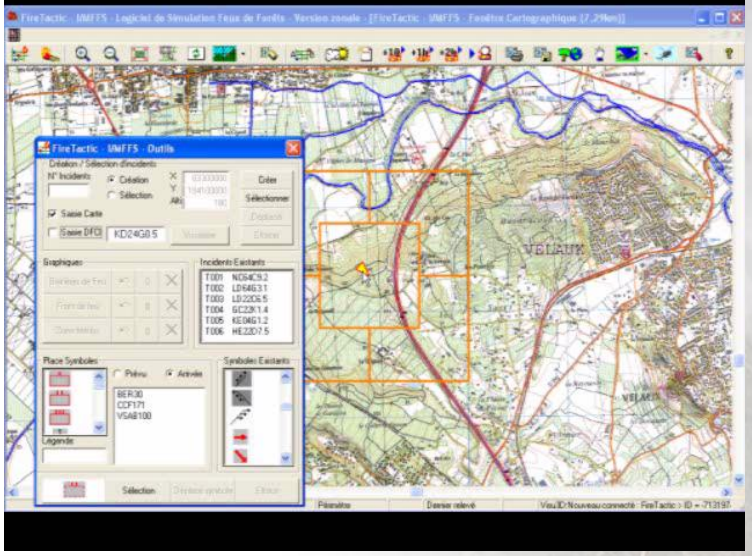
Forest Ranger – Fire Management Tools

Fire management Interface:

- Data communication with dispatching system for visual data exchange
- Fire propagation
- Identification of resources
- Position of resources
- Movement of resources
- Strategic coordination of resources
- Identification of fire position
- Propagation of fire development





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Lesson learned in application South of France

- **Video system is not really sufficient for early detection, but monitoring**
- **Early detection requires different technology to meet the requirements for a fast and efficient fire fighting (rapid initial strike)**
- **There are no existing specification or regulations for detection systems and monitoring systems**
- **Parameters for detection, data, interfaces and interoperability are not common agreed**
- **Many countries operates Video systems without significant improvement of fire situation (burned area)**
- **A detection system can only be effective, when implemented into a fire management concept and –system**
- **A detection system should provide additional features like „geosensing"™ or „tree observe"™**

(statements from long term operation and evaluation at Dep.SDIS13 Fire Management Center)

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Best reasons for need of common specification and standardisation:

No Forest Ranger Test-system involved

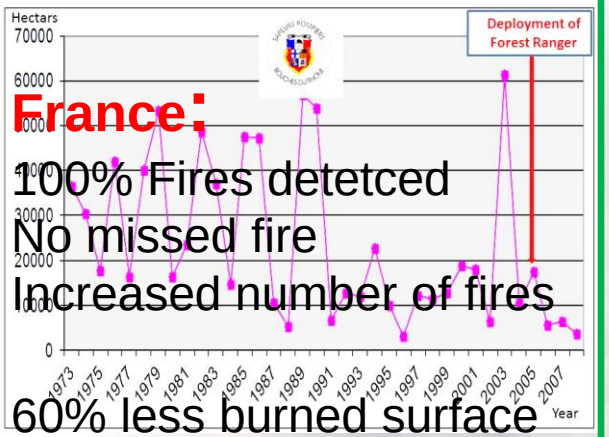
Australia : 47 Test Fires started :

45 where reported by lookout before any detection system
= no detection system alerted faster than lookout
1 system detected only 28 test fires
1 system detected only 15 test fires

Detection times where in av. 35- 224minutes

Localization errors was up to 10km from the correct position

Forest Ranger in Operation



France:
100% Fires detetced
No missed fire
Increased number of fires
60% less burned surface

Conclusion:
To utilize effective and reliable detection systems for a fire management, it needs common specifications and standardisation.

Source:
http://www.ag.gov.au/www/agd/agd.nsf/Page/Publications_Evaluationofthreefiredetectionsystems-8October2010#LinkTarget_1083 (Australia)

France Fire Management Center Marseille (France)

Forest Ranger

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Leave it as it is…

or

…. stop it before …

Thank You for Your Attention

Joachim F. Dreibach

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Forest Ranger
-
non-stop sentinel for early detection and more

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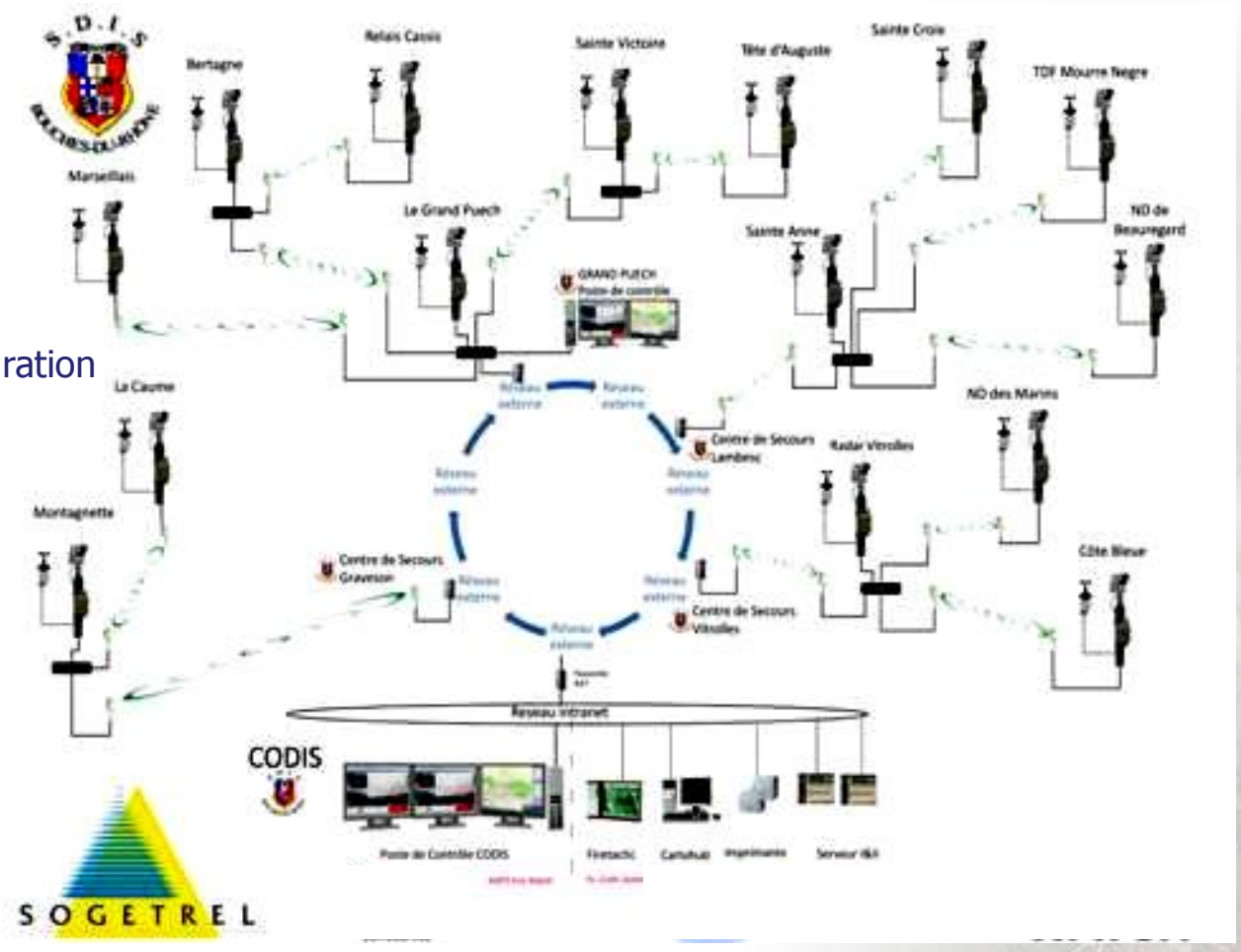
System Concept for SDIS13 France

16 sensor´s
2Control Office
Radio Network
Power
FTP Storage
3D GIS communication
Fire management integration
Meteo Stations

24Hrs Service Contract



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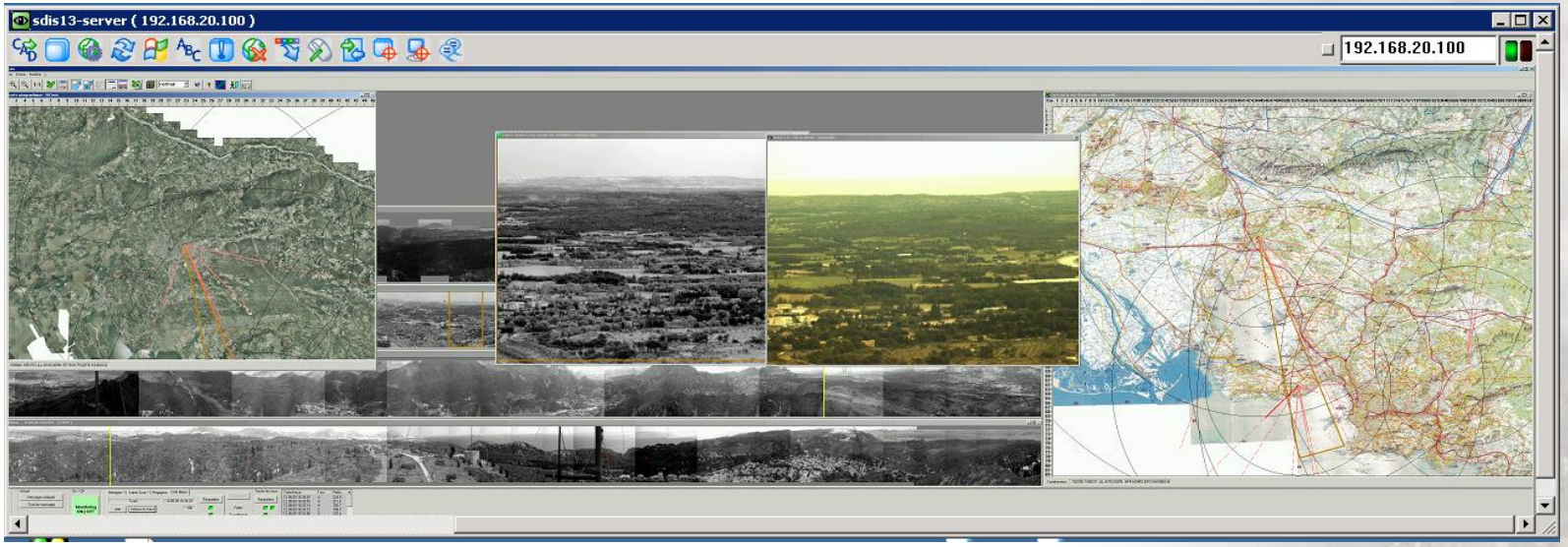
Examples of commercial installations in operation

- **Operator:** Service Départemental d'Incendie et de Secours des Bouches-du-Rhône (SDIS13) Marseille (France)
- Test phase completed: 2004 - 2006
- EU-Tender won (commercial ops) May 2007
- Planned systems: 16
- Area covered: 31400km^2

Forest Ranger

- Control Center (CODIS)
  in the operation room SDIS13



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Outlooks Reganaz & Bertagne (France)

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Outlook St. Croix

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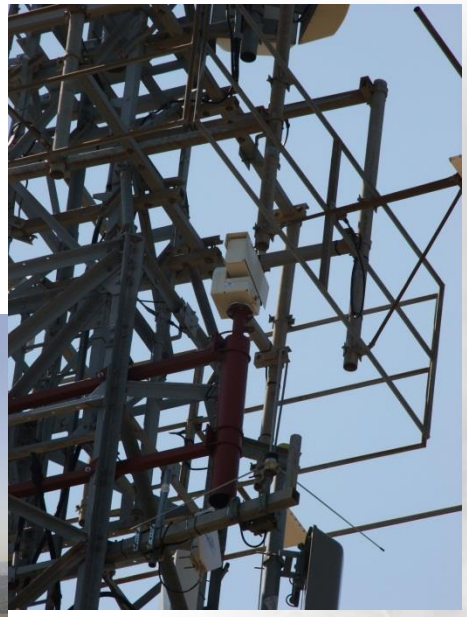
Sensor La Saoupe



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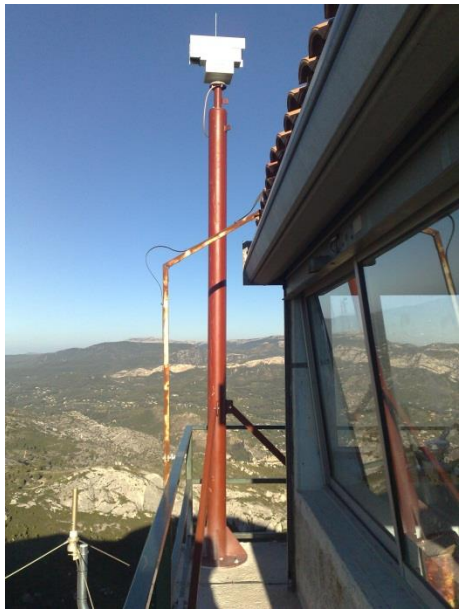
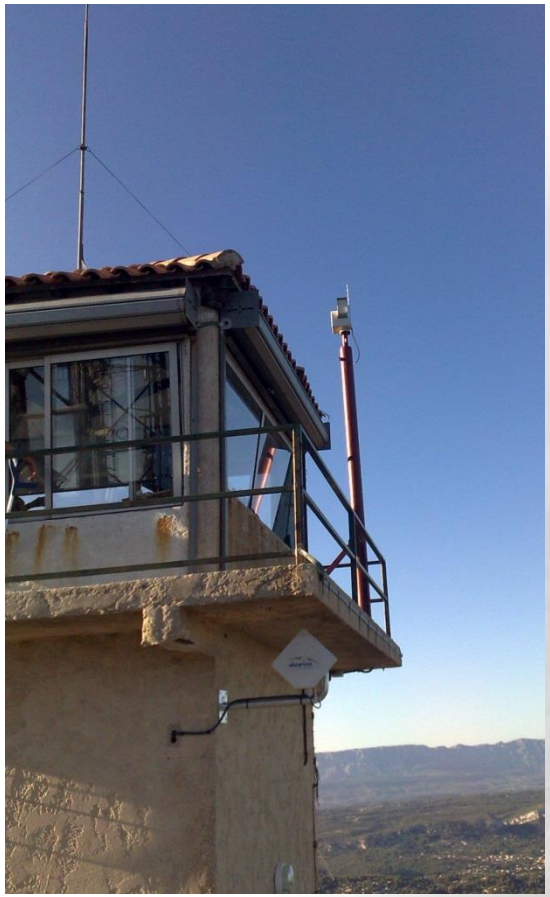
Outlook Marseillais





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Installation sample spain (trial)

- **Operator**: Junta de Andalucia Consejeria de Medio Ambiente Sevilla (España)

- Test phase completed: 2008
- Planned systems: ???

Installation 2

- **Operator: National Park Collserola**
- Test Phase start 1. December 2012
- 3 Sensors
- 2 Control Office

(after two other systems failed Qualification)

Forest Ranger

Outlook Cordoba Los Vilares (Spain)