Web GIS platform for forest fire management

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Prof. George Kallos – Univ. of Athens, Dept. of Physics, Greece

Research Group:

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J. Dimou – G. Hiotellis – G. Aggelopoulou – M. Kyrou

Dr. G. Galanis – Dr. C. Mitsakou – C. Spyrou – N. Hatzopoulos

Microsoft Research – Microsoft, Redmond, USA

Microsoft Hellas – Microsoft Innovation Center, Greece

Virtual Fire

Final Review & PR Event

July 5-6, 2010

Mytilene, Greece

Objective of the research:

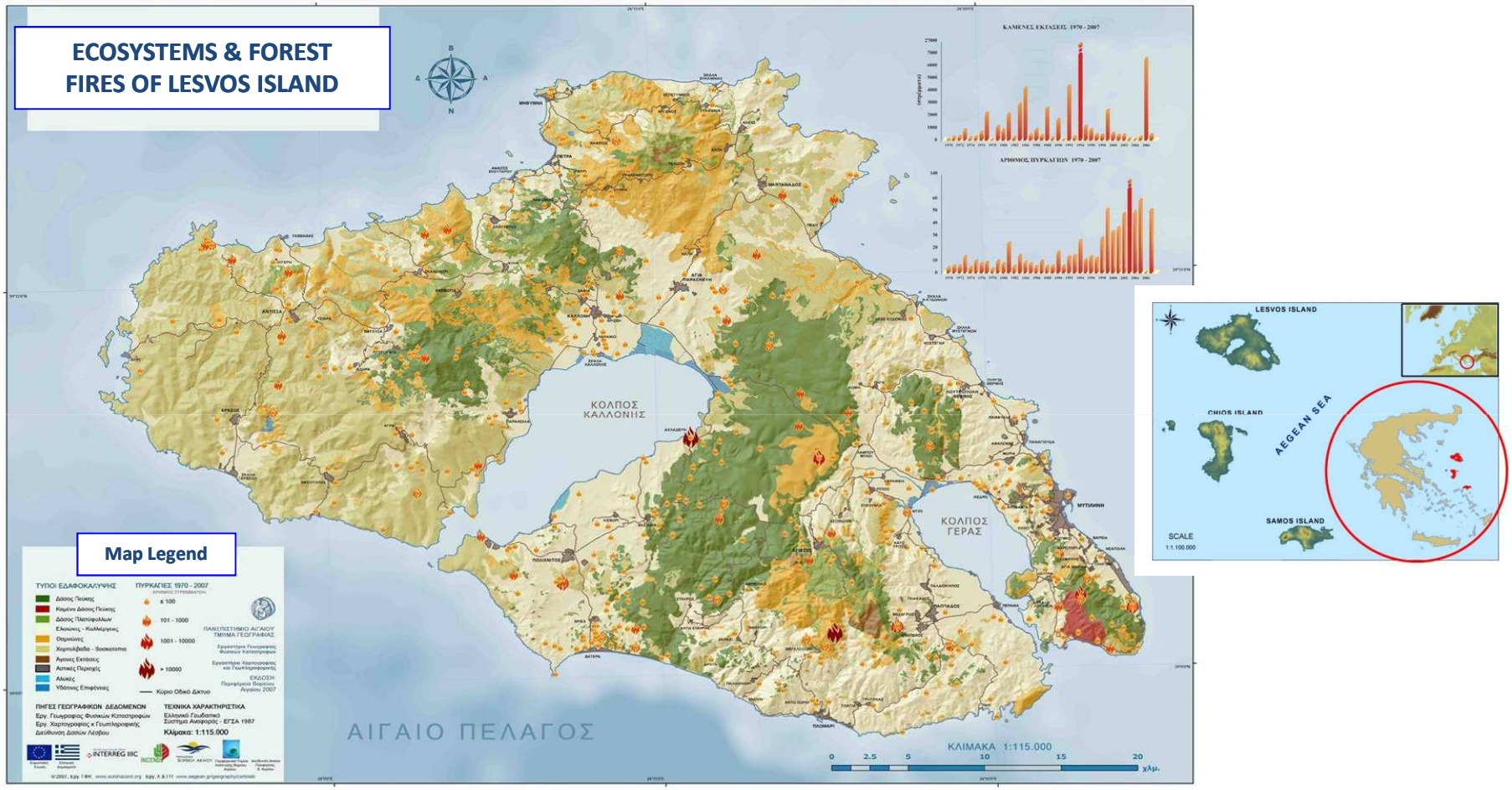
new Web GIS application of Microsoft® Bing™ Maps aimed to assist on early fire warning, fire control, and GPS navigation and coordination of firefighting forces

Identity of the research

- *Virtual Fire* (VF) is a research project run by University of the Aegean, and supported by University of Athens and Microsoft Hellas/MIC in Greece; and funded by *Microsoft Research*.
- VF is a fully stand-alone, web-based early warning and decision support system for integrated forest fire management, based on geo-informatics and IT modeling.
- The main concept of the project is that firefighting forces need a tool to easily, validly, promptly and immediately access geographical and relational data during a fire event, without the knowledge of handling complicated GIS applications and the installation of special desktop software.
- End-users will be able to access 3-day weather forecasting maps, daily fire risk maps, real-time fire behavior maps, vehicle and resource positions, high-resolution satellite images etc., all through a simple Internet connection of their portable computer or GPS with the VF platform.

Pilot case study: Lesvos Island, Greece

w/ an area of 1,636 km² & 90,000 residents, located at northeastern Aegean Sea

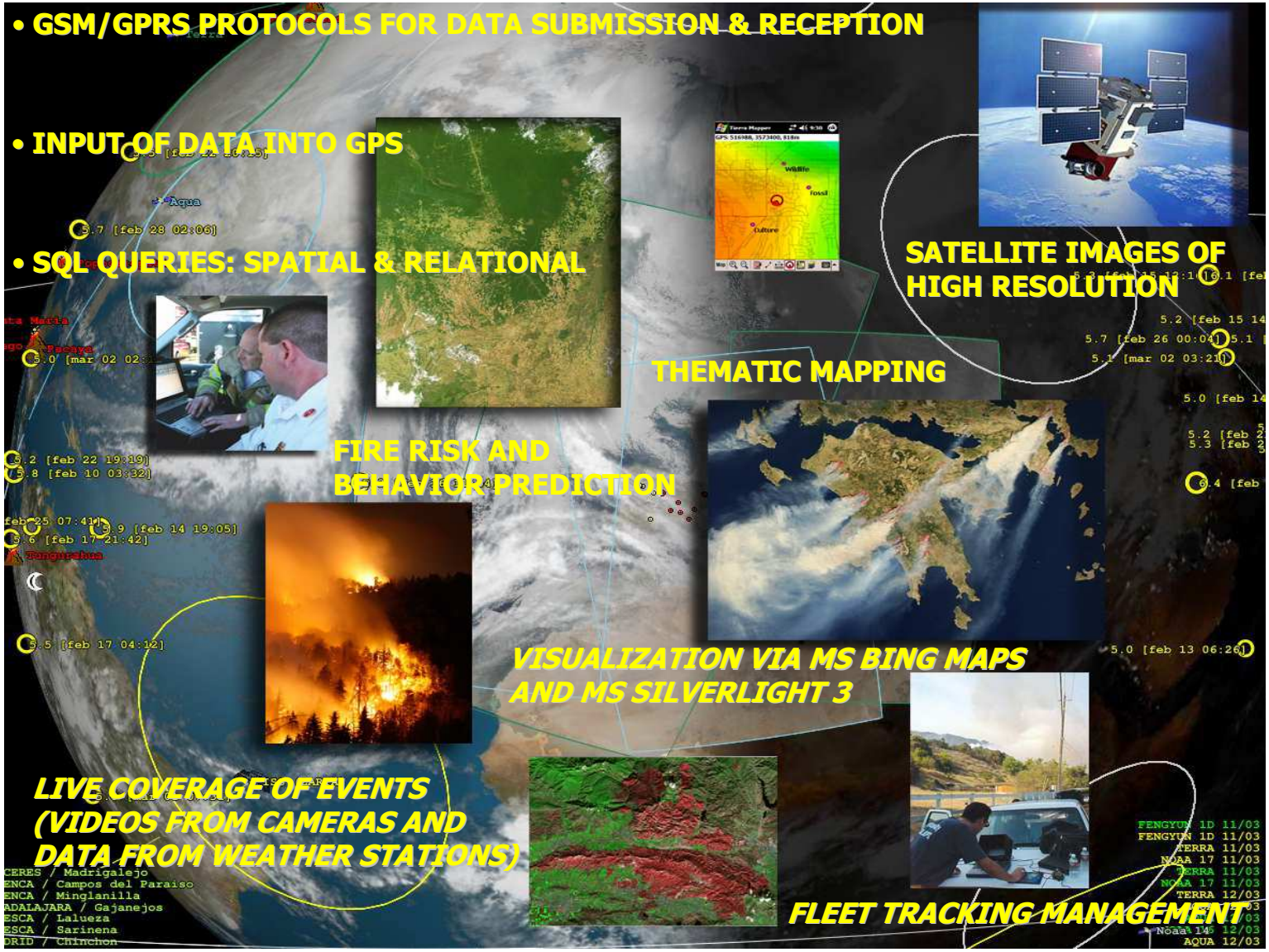


Fire-prone and high-risk area of Greece: more than 600 wildfires, mostly human-caused, occurred between 1970-2009 resulting in about 9,000 hectares of total area burned

Design of services offered to forest fire and civil protection agencies through the VF management system:

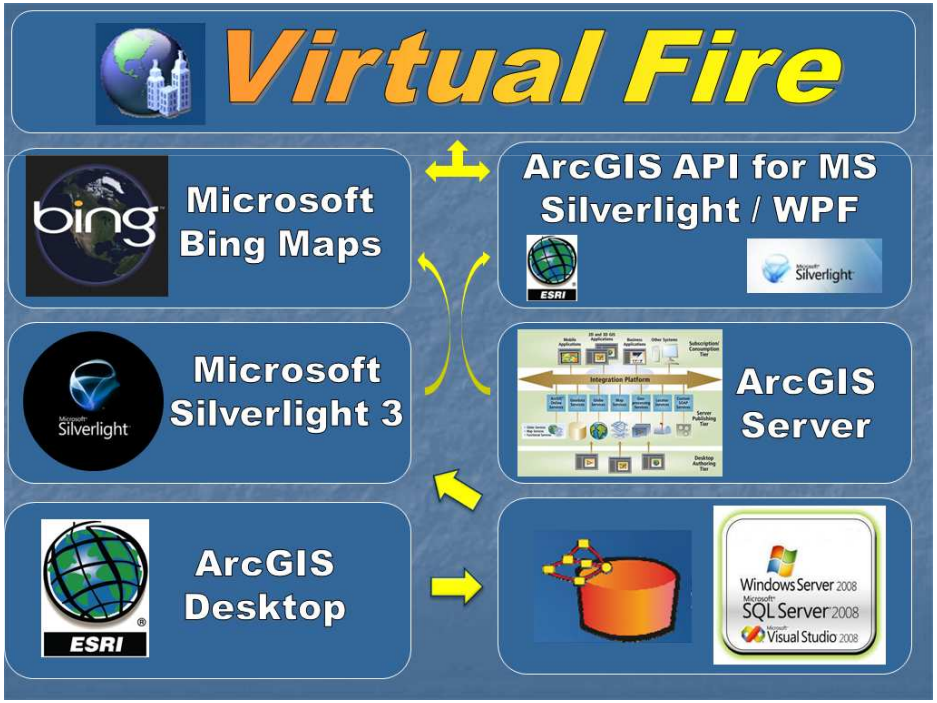
1. Remote automatic weather stations and a weather forecasting system provide all the necessary fire meteorology info for fire prevention, early warning, and control
2. Geographical representation of the fire risk potential and identification of high-risk areas at different local regions are provided on-demand, based on meteorological, socio-economic, and biophysical parameters
3. Maps that represent the spread and intensity of a forest fire at different times and places; thus, authorities will have the ability to design an operational plan to encompass the forest fire, choosing the best way to put out the fire with the proper means at the proper time
4. On-line and real-time location of Fire Service vehicles and other resources by using GPS and communications that transmit the coordinates of each item to the system, portraying them on an electronic map/ video wall; thus, achieving better coordination in emergency response & resource dispatching
5. *In-situ* detection cameras along with prompt satellite images are of added value as integrated extensions to the VF platform
6. State-of-the-art know-how and advanced computing schemes; e.g. spatial modeling, GIS and remote sensing, specialized software and algorithms, and high performance computing (HPC).

Technical contents of the research



Technologies and platforms employed

- Virtual Fire is based on *ESRI ArcGIS* commercial software: maps and functions are created within this software in close integration with *MS SQL Server 2008*; outcomes are published to the web via the *ArcGIS Server*; *MS Visual Studio 2008* combines them all with *MS Silverlight 3* by using components of ArcGIS API for MS Silverlight / WPF.
- *MS Bing Maps* (ex *Virtual Earth*) is the primary mapping information platform, and all data and maps are displayed as overlays on top of it.
- The integration of the above plus the addition of other components from external sites comprise the VF software architecture.



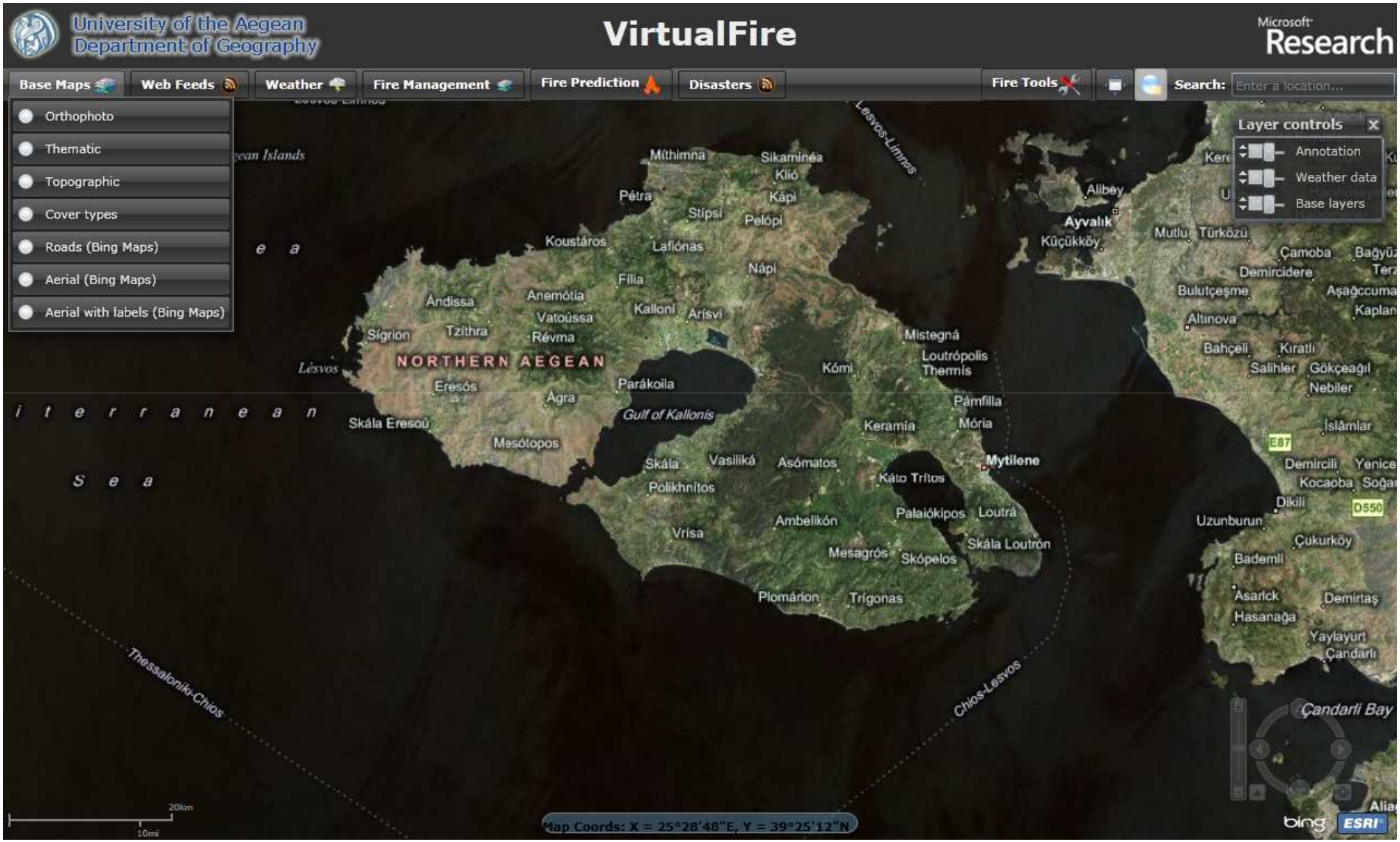
Other technologies and platforms employed

- Use of *ESRI ArcSDE* geo-databases to store geographic and other data (compliant with *MS SQL Server 2008*)
- Use of *SKIRON* weather prediction HPC models (University of Athens) to create weather forecasting maps
- *FARSITE* and *Flammap* fire growth and behavior simulation models to predict fire behavior
- Neural networks for fire risk mapping (*Windows HPC Server 2008* compliant software developed by the project)
- GPRS / GSM protocols for data transmission.

Overall Project Achievements

1. Ability to select among the *Bing Maps* database and several other layers (high-resolution satellite images, ortho-photos, thematic maps, topographic maps)
2. GeoRSS live data streams for new fire events, with ability to add new events
3. Ability to monitor and survey several weather forecasting maps (temperature, relative humidity, cloud cover, rain and wind), with a prediction range of 3 days and update once every day (09:00 am local time)
4. Access to data of 5 Remote Automatic Weather Stations (RAWS) with real-time diagrams and weather monitor graphics
5. Ability to access several different fire/ disaster management data (road network, water tanks, evacuations areas, etc.), and switch among them at will
6. Daily fire risk maps that portray the potential of fire occurrence, based on a high performance computing (HPC) pilot application with Microsoft Windows HPC server
7. On-demand fire behavior modeling
8. A rich toolbox with mapping and other tools that enhance interoperability (shortest routes, closest water tanks, service areas, measurement and digitizing tools, e-mails, fleet tracking, web-cameras, etc.)
9. Daily updated world satellite imagery courtesy of NASA/GSFC/JPL-Caltech, OnEarth, MODIS Terra (WMS map); and other live feeds of worldwide disasters
10. GPS navigation and data collection utility with Windows Mobile Operating System.

BING MAPS


University of the Aegean
Department of Geography
VirtualFire
Microsoft Research
Base Maps
Web Feeds
Weather
Fire Management
Fire Prediction
Disasters
Fire Tools
Search:
Enter a location...
Orthophoto
Thematic
Topographic
Cover types
Roads (Bing Maps)
Aerial (Bing Maps)
Aerial with labels (Bing Maps)
Layer controls
Annotation
Weather data
Base layers
NORTHERN AEGEAN
Lésvos
Gulf of Kallonis
Mytilene
Míthimna
Sikaminéa
Klió
Pétra
Kápi
Stípsi
Pelópi
Koustáros
Lafiónas
Nápi
Filia
Ándissa
Anemótia
Vatoússa
Kalloni
Arísvi
Sígrion
Tzíthra
Révma
Eresós
Ágra
Parákoila
Skála Eresoú
Mesótopos
Kómi
Mistegná
Loutrópolis Thermís
Pámfilla
Keramía
Mória
Skála
Vasiliká
Asómatos
Káto Tritos
Polikhnítos
Ambelikón
Palaiókipos
Loutrá
Vrísa
Mesagrós
Skópelos
Skála Loutrón
Plomárion
Trigonas
Alibey
Ayvalık
Küçükköy
Mutlu
Türközü
Çamoba
Demircidere
Bulutçeşme
Altınova
Bahçeli
Kıratlı
Salihler
Gökçeağıl
Nebiler
İslâmlar
E87
Demircili
Yenice
Kocaoba
Dikili
D550
Uzunburun
Çukurköy
Bademli
Asarlık
Demirtaş
Hasanağa
Yaylayurt
Çandarlı
Çandarlı Bay
Thessaloniki-Chios
Chios-Lesvos
Lesvos-Limnos
Map Coords: X = 25°28'48"E, Y = 39°25'12"N
20km
10mi
bing
ESRI

HIGH-RESOLUTION SATELLITE IMAGES

BASE MAP SELECTION

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GEO-RSS WEB FEEDS

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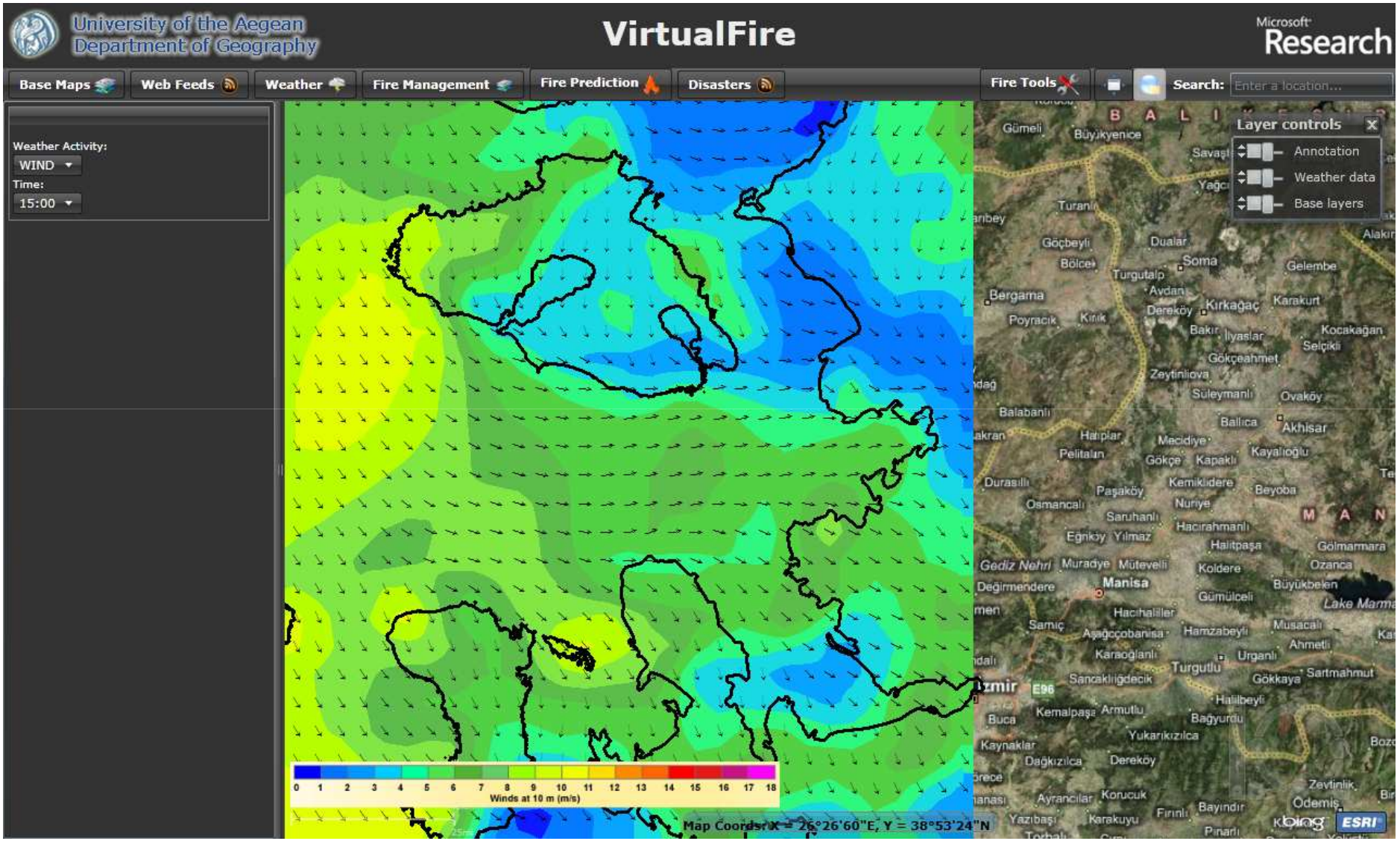
WEATHER PREDICTION MAPS



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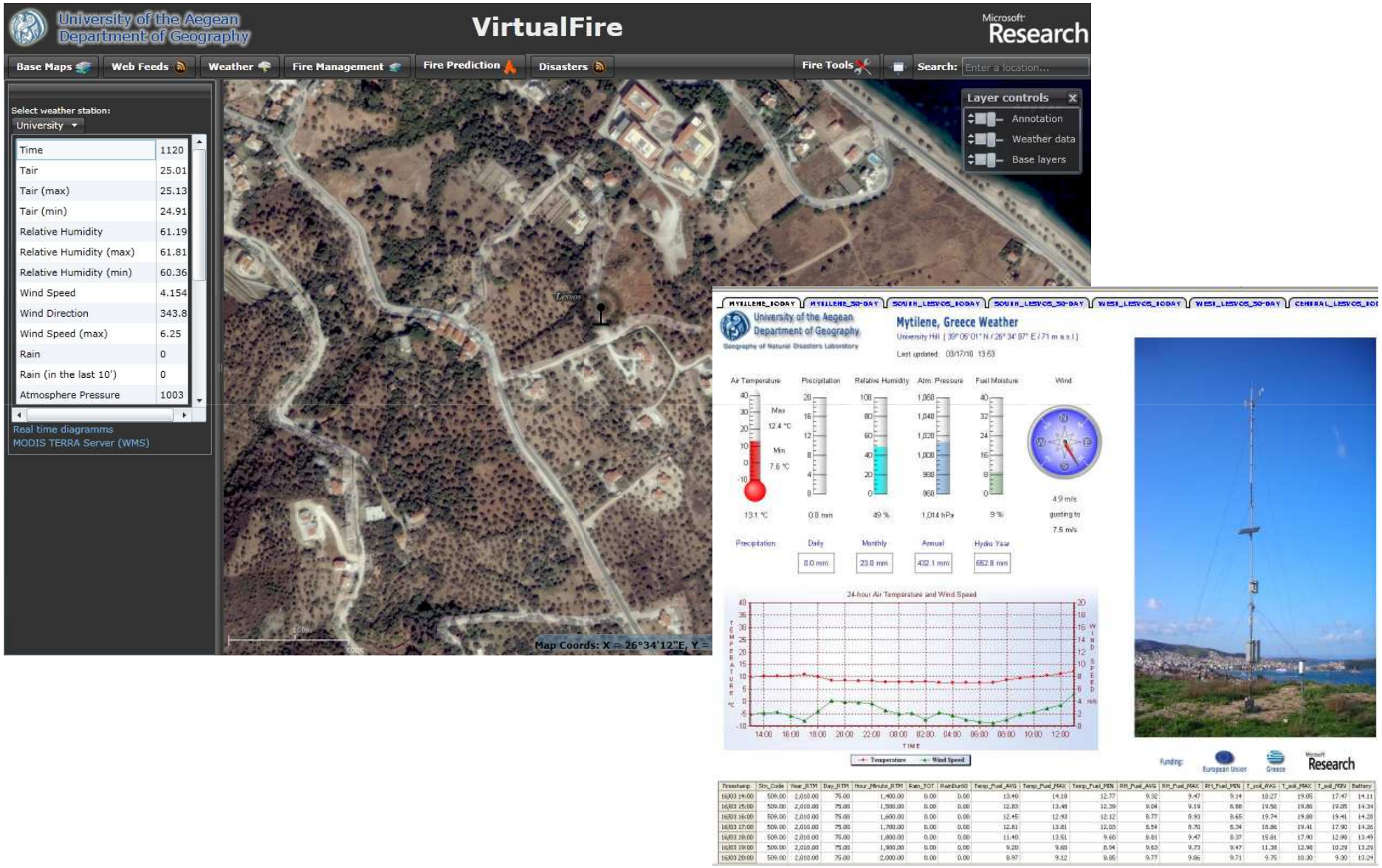
ONLINE WEATHER MONITORING



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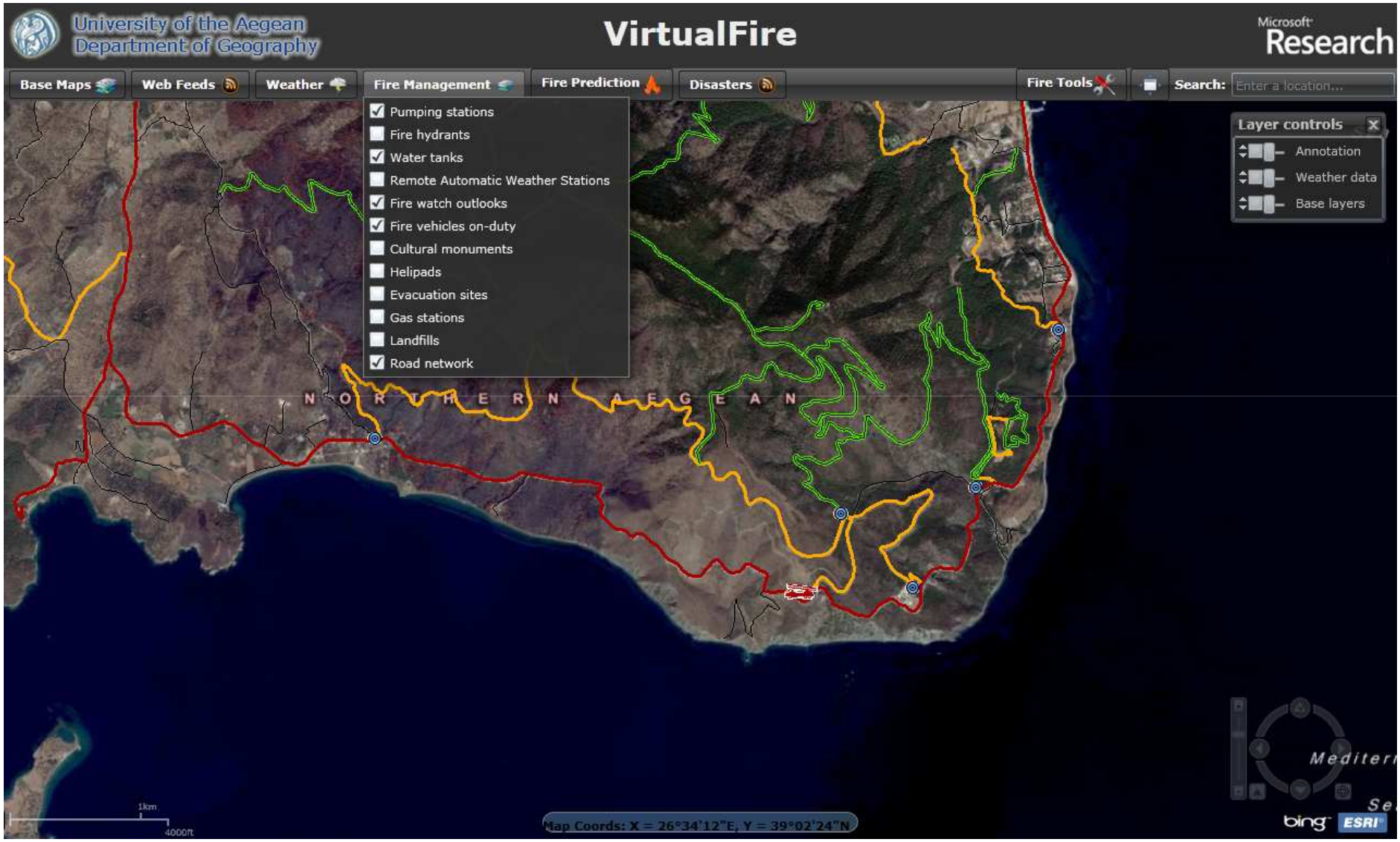
FIRE MANAGEMENT DATA



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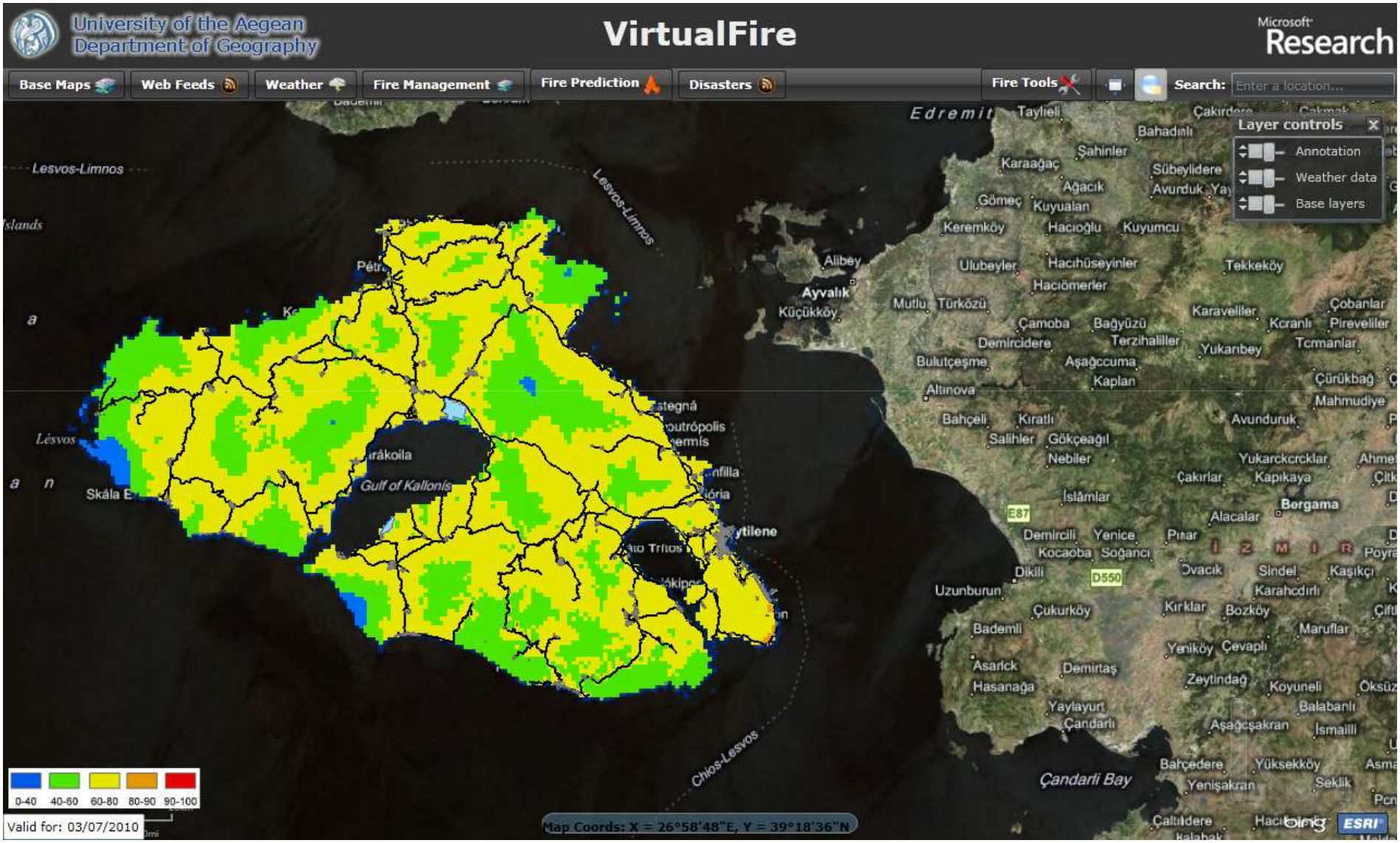
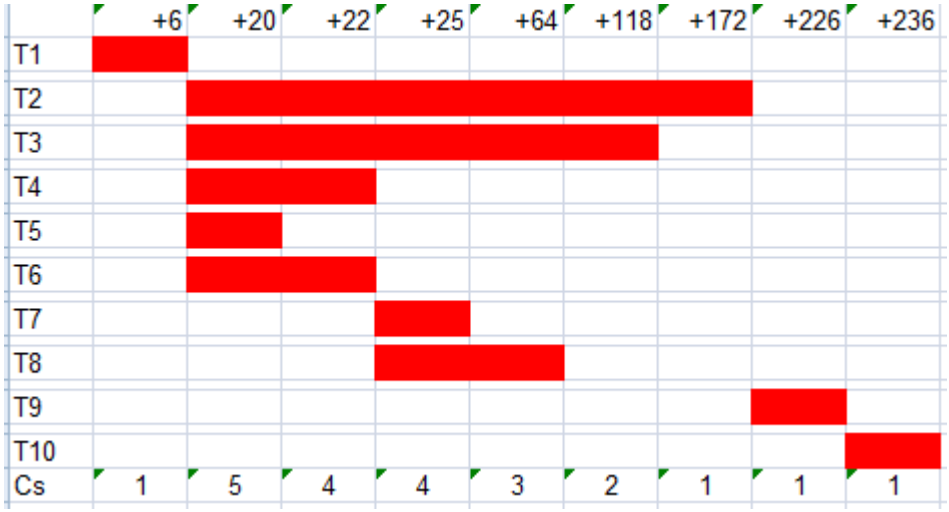
FIRE RISK MAPPING



Fire Risk Mapping w/ Microsoft Windows HPC Server

- implementation of parallel computing / HPC in geospatial problems
- large geographical extent & spatial resolution need increased computing power
- the thread model approach from sequential to parallel utilized
- computation speed increase of about 33% (with 2 computing nodes, 8 cores total)
- processing avg. time: sequential = 333 sec vs. HPC = 224 sec
- easy to be implemented from a non IT end-user
- fast network required, i.e. Infiniband
- expensive third party components need to be installed in every computing node



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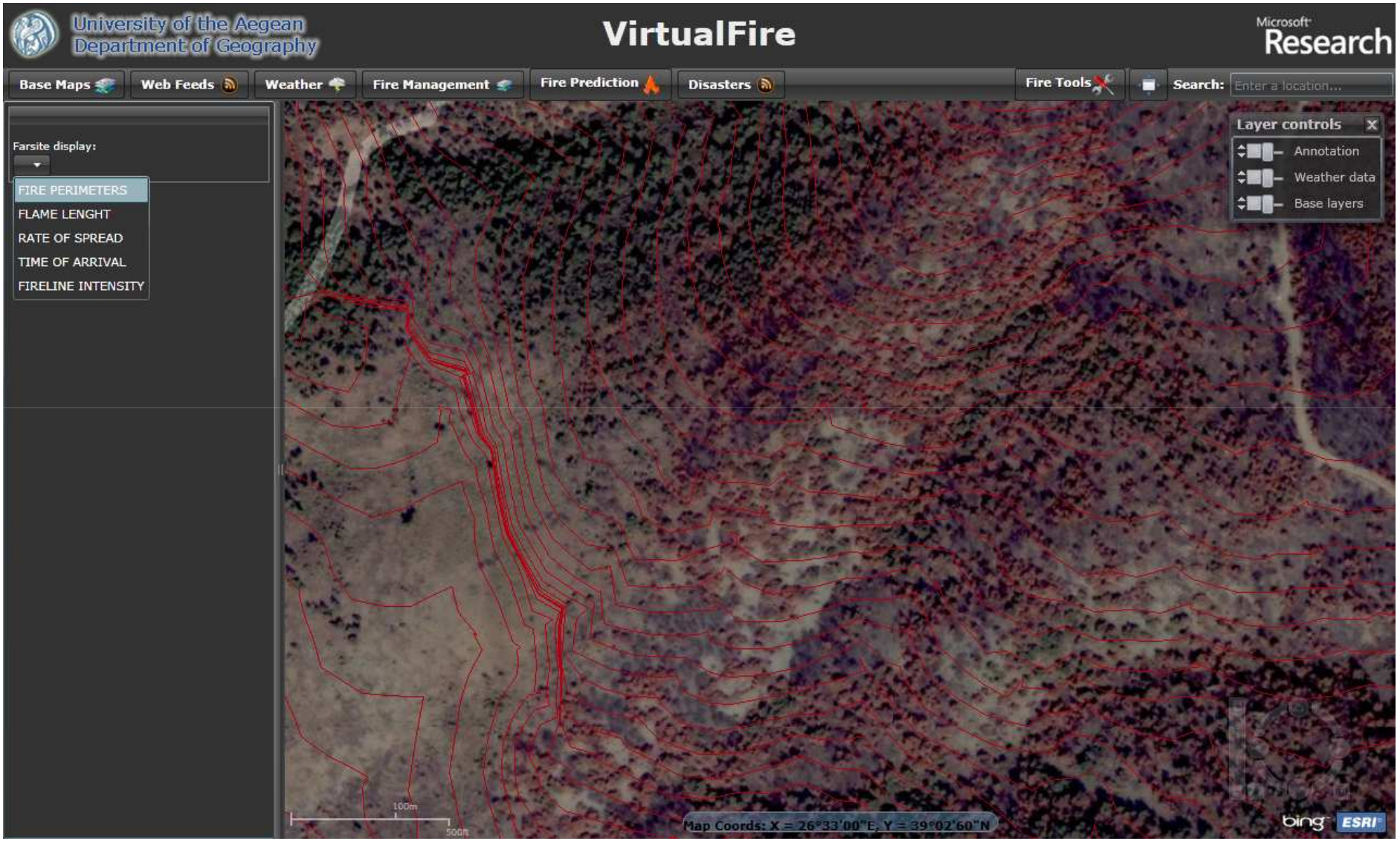
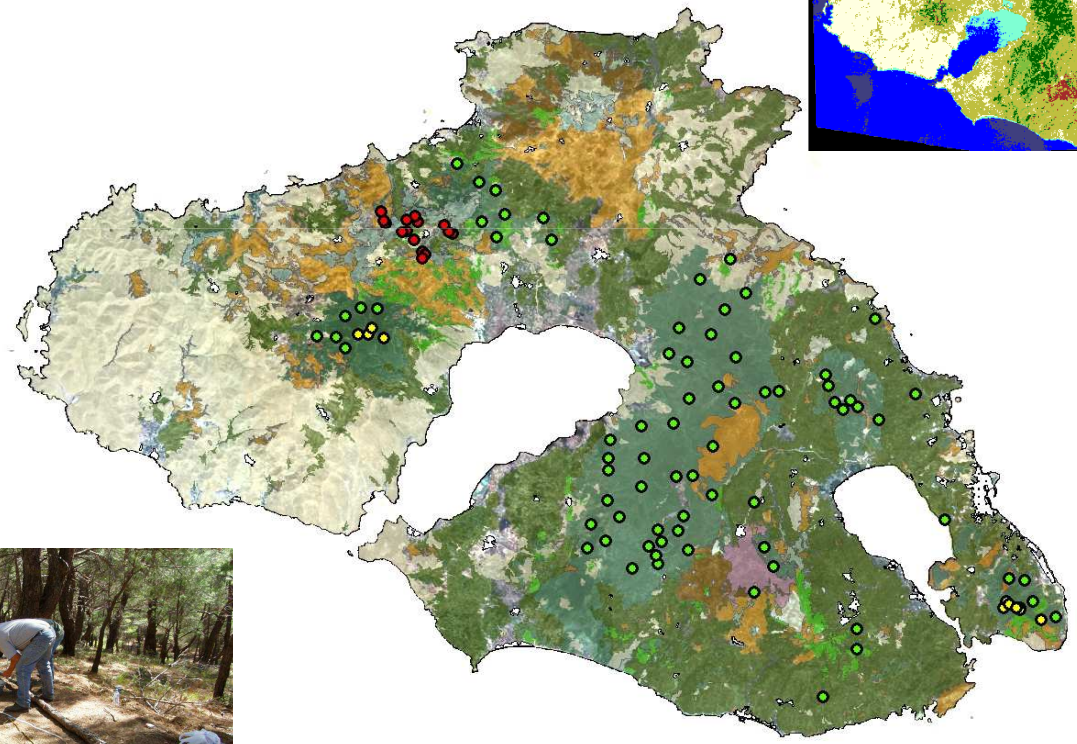
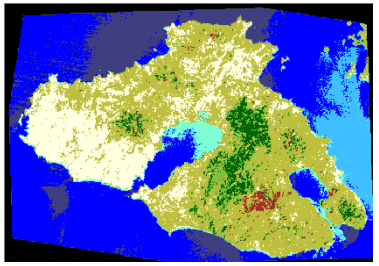
FIRE BEHAVIOR MODELING



FIRE BEHAVIOR MODELING

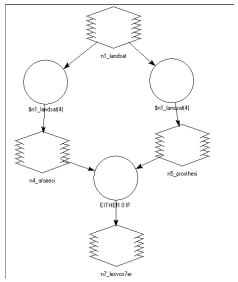
All the necessary land cover data for the creation of a permanent ready-to-launch fire prediction application were inventoried and analyzed; and cover / fuel types were mapped using geo-statistics and GIS techniques.





Multivariate statistical model

$$g(\mu) = \beta_0 + \beta_1 x_1 + \cdots + \beta_n x_m$$



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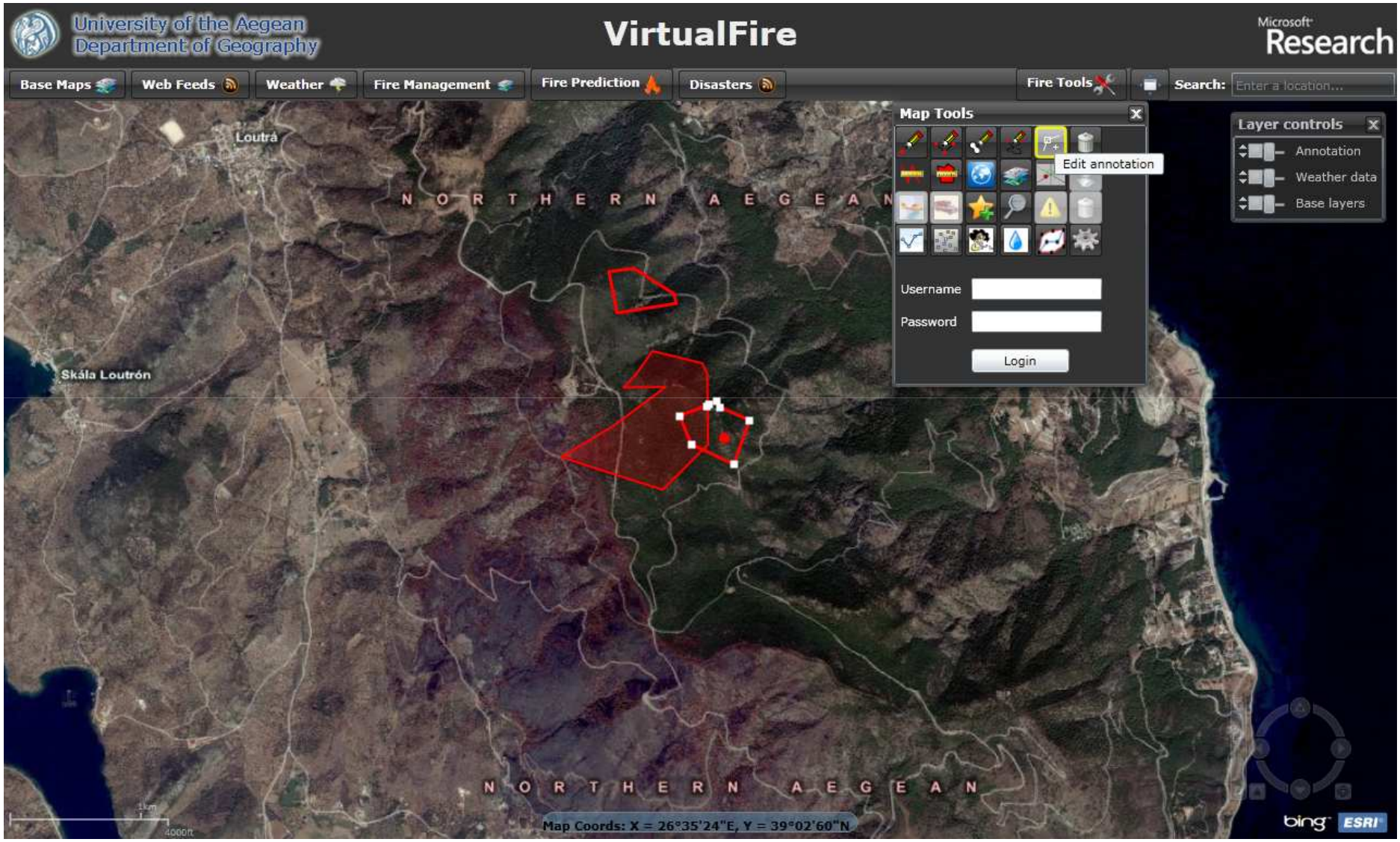
FIRE MAP TOOLS

SKETCH TOOLS

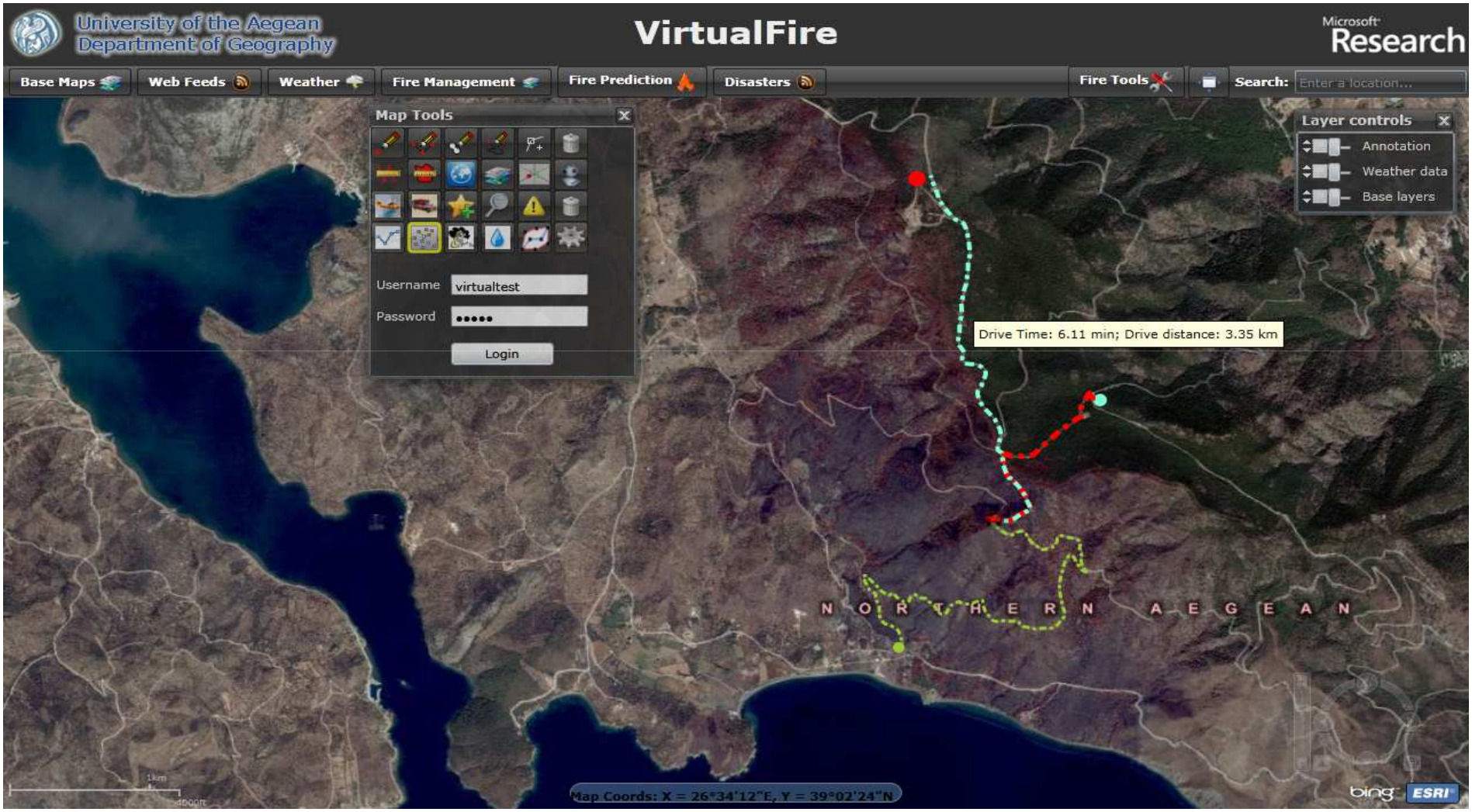


DISTANCE MEASUREMENTS

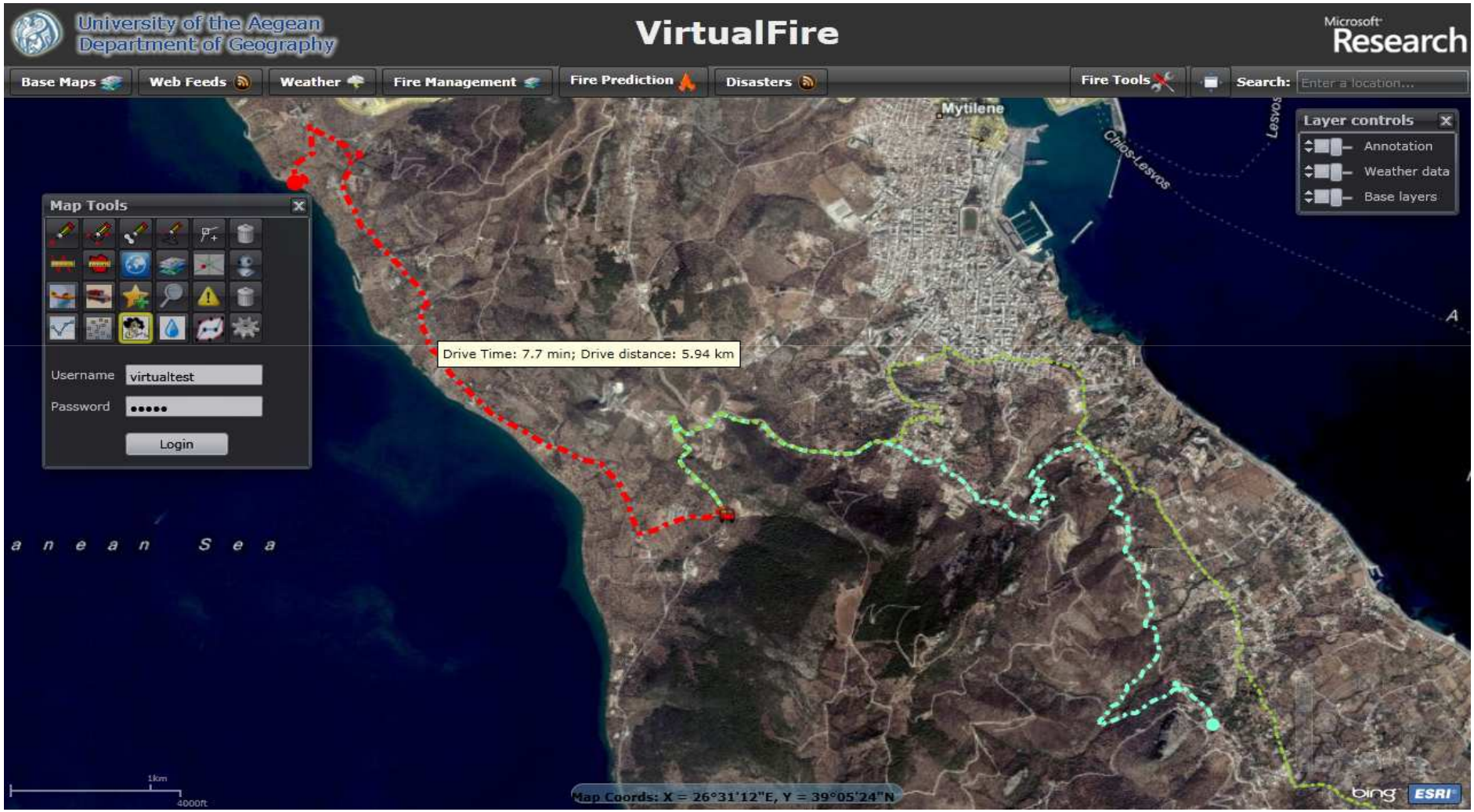
DRIVE TIMES


University of the Aegean
Department of Geography
VirtualFire
Microsoft Research
Base Maps
Web Feeds
Weather
Fire Management
Fire Prediction
Disasters
Fire Tools
Search:
Enter a location...
Click on map to:
Find street names
Find shortest routes
Remove selection
Find
clear
Map Tools
Username
virtualtest
Password
Login
Layer controls
Annotation
Weather data
Base layers
NORTHERN AEGEAN
Lesvos
Aegean Islands
10 minute access
Aegean Sea
Chios-Lesvos
Mediterranean Sea
Pérama
Map Coords: X = 2959752.99, Y = 4725813.77
bing
ESRI

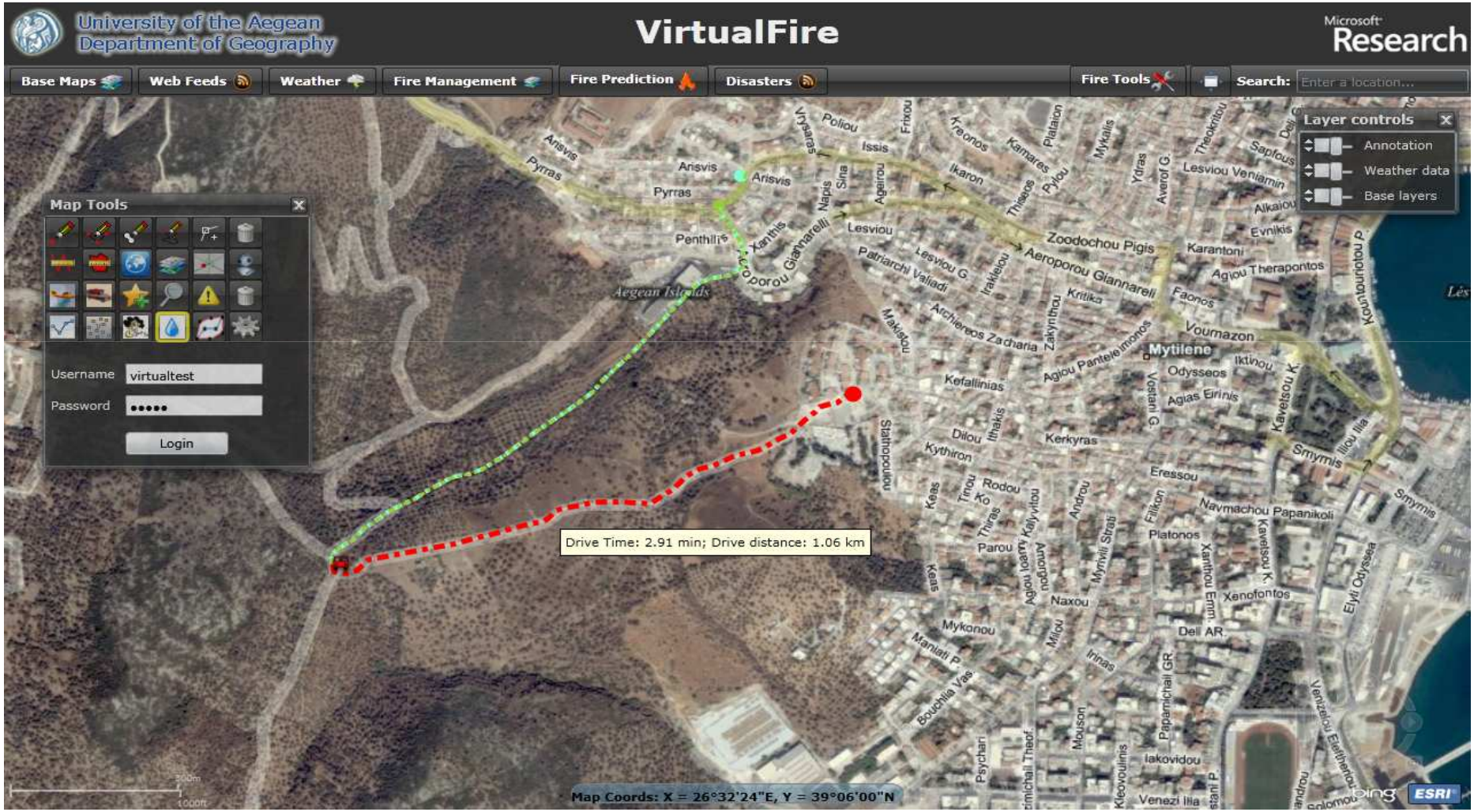
FIND CLOSEST WATER TANKS



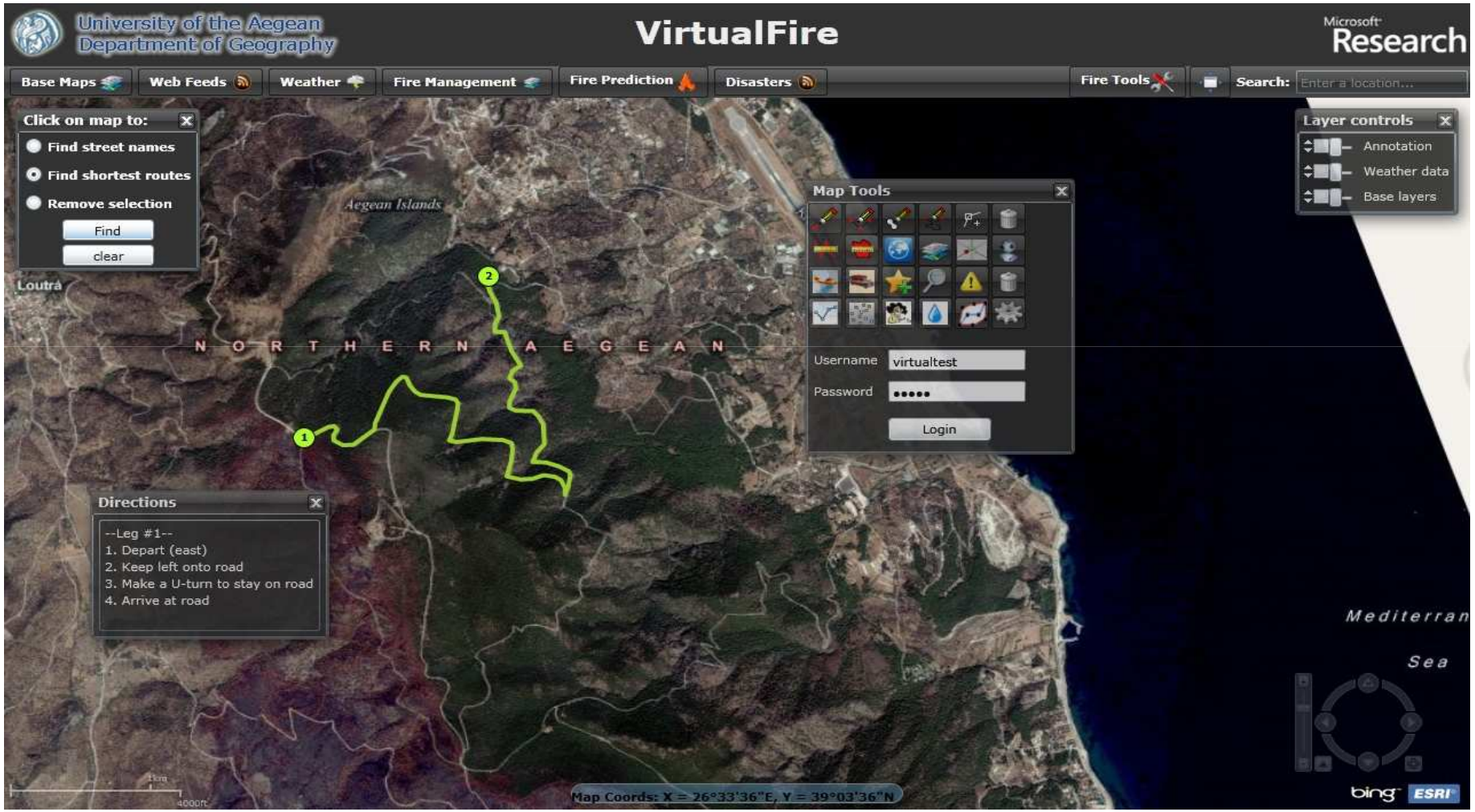
FIND CLOSEST PUMPING STATIONS



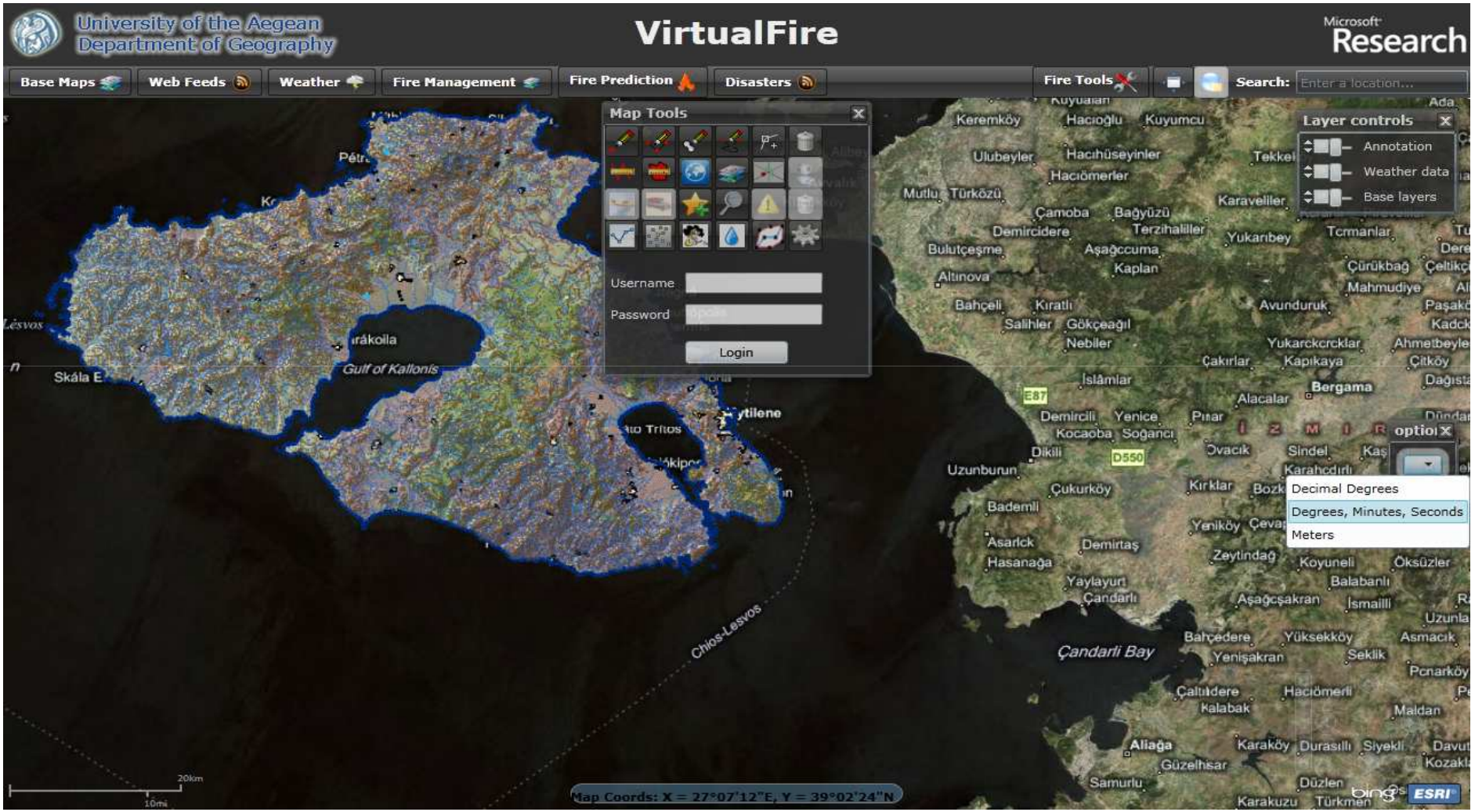
FIND CLOSEST HYDRANTS



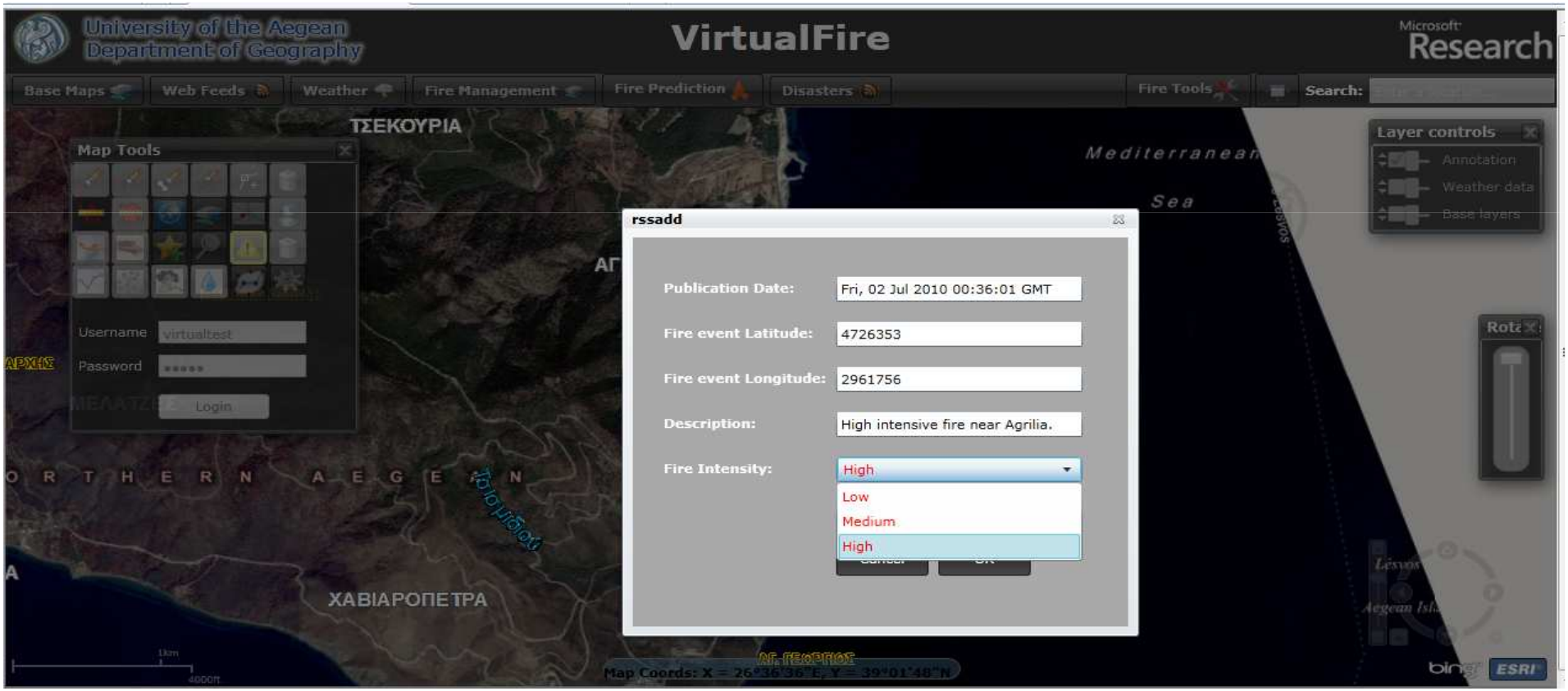
FIND SHORTEST ROUTES



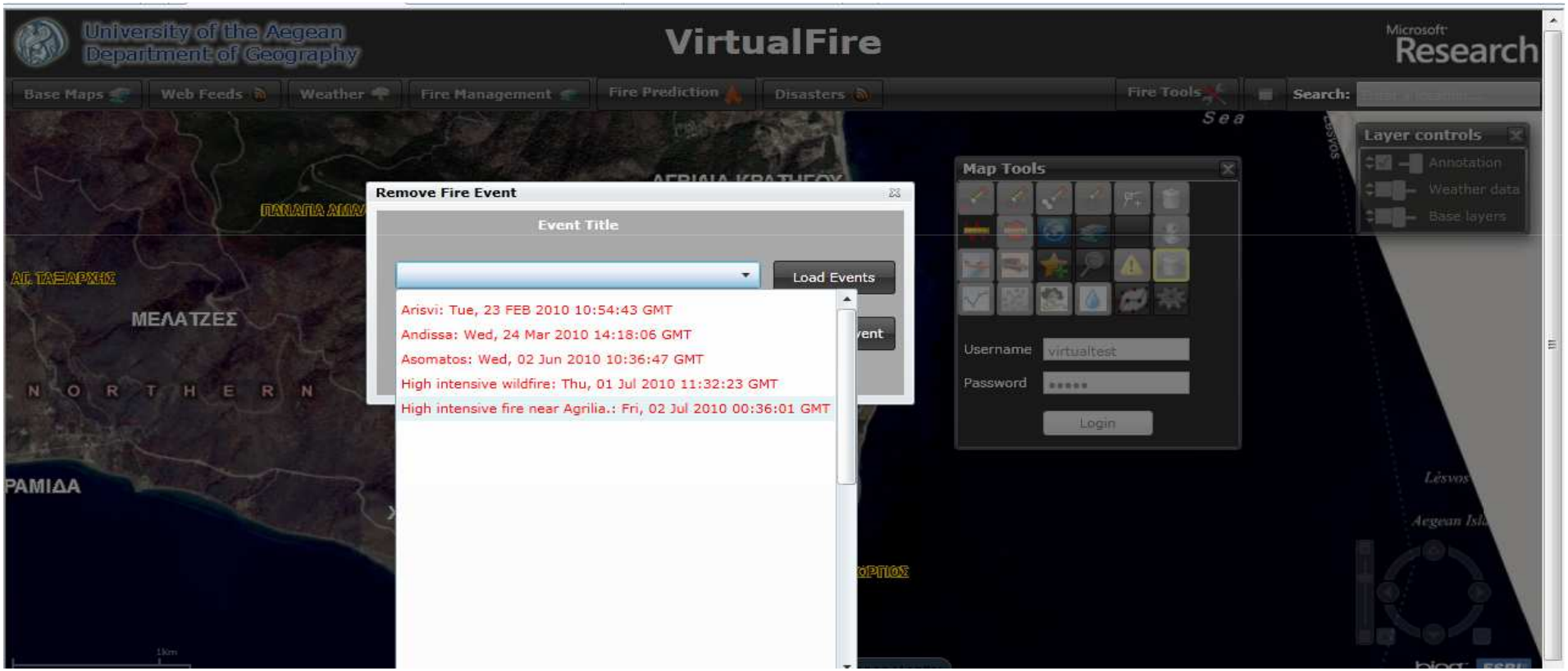
FORMAT CHANGE OF COORDINATES



ADDITION OF NEW FIRE EVENTS

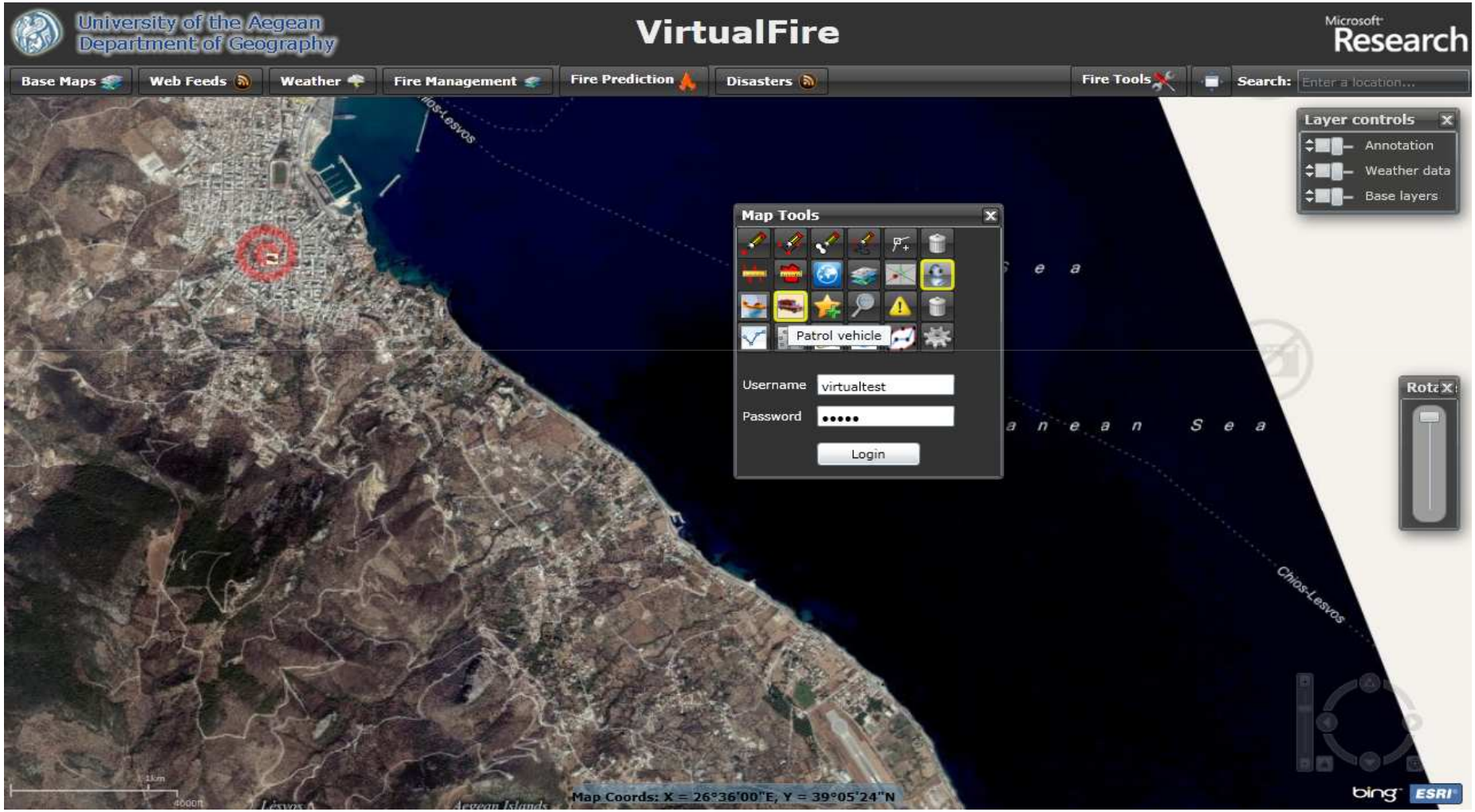


REMOVAL OF OLD FIRE EVENTS



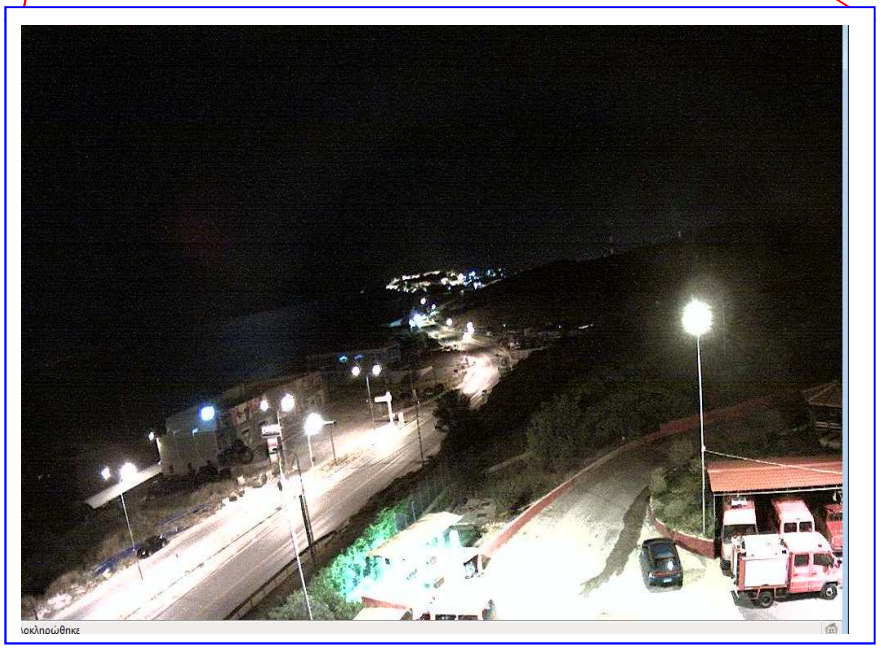
E-MAILS FROM END-USERS

REAL-TIME TRACKING OF FIRE SERVICE VEHICLES



REAL-TIME TRACKING OF FIRE PATROL & SUPPRESSION AIRCRAFTS

LIVE CAMERA IMAGES



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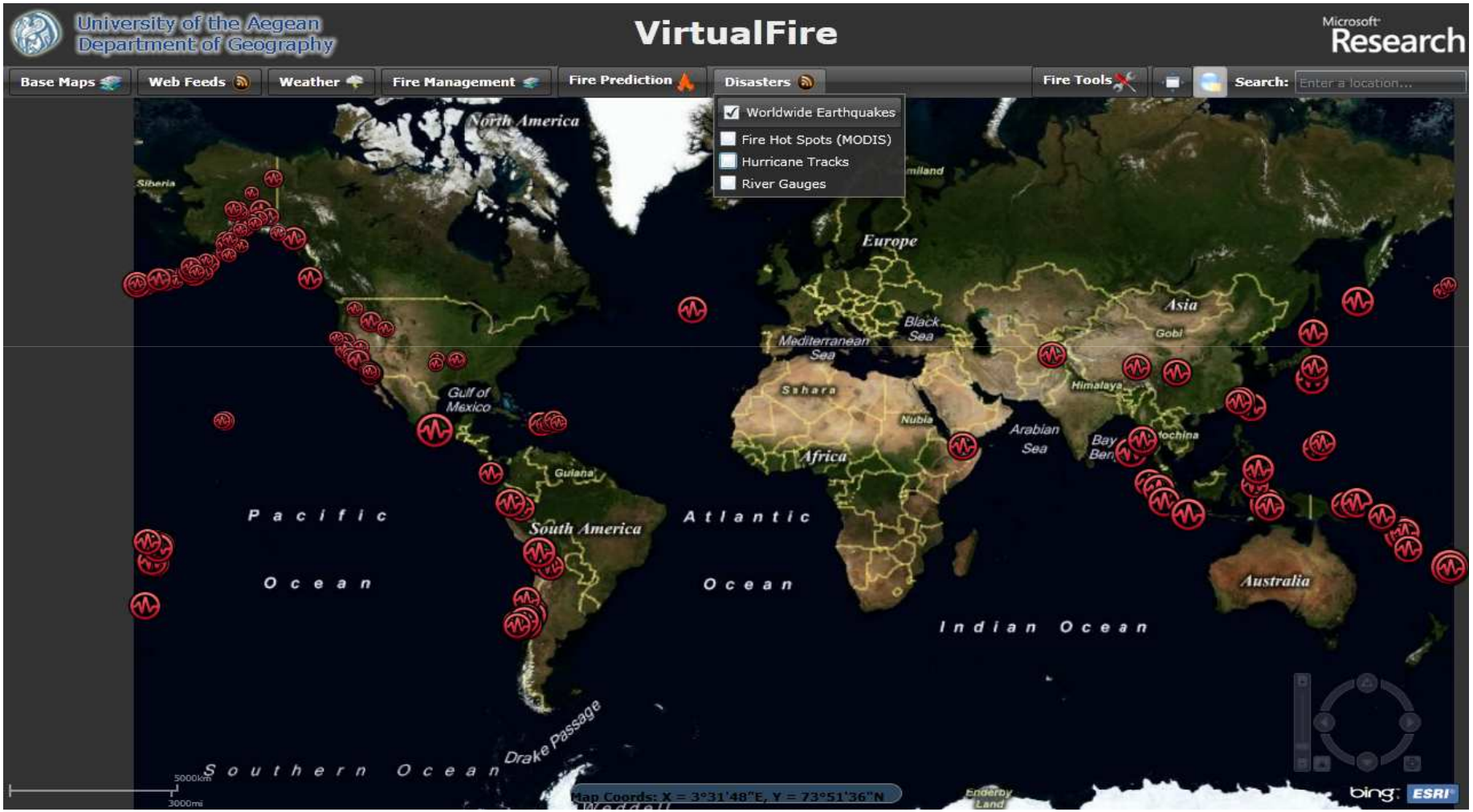
MODIS TERRA SATELLITE IMAGES (Daily Planet)

Live Feeds: Earthquakes (USGS)



Live Feeds: Fire Hot Spots (MODIS)

Live Feeds: Hurricane Tracks (NWS)

Live Feeds: River Gauges (NWS)

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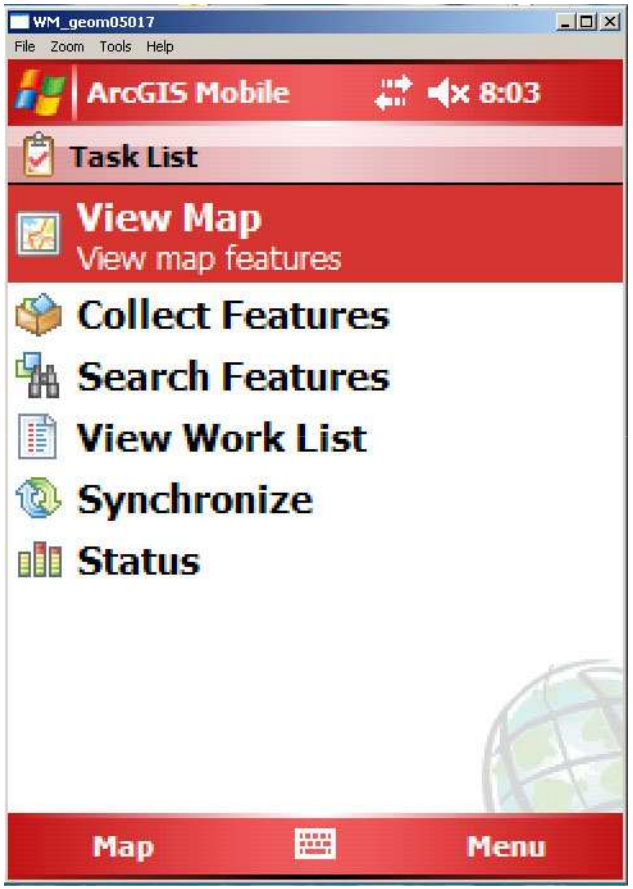
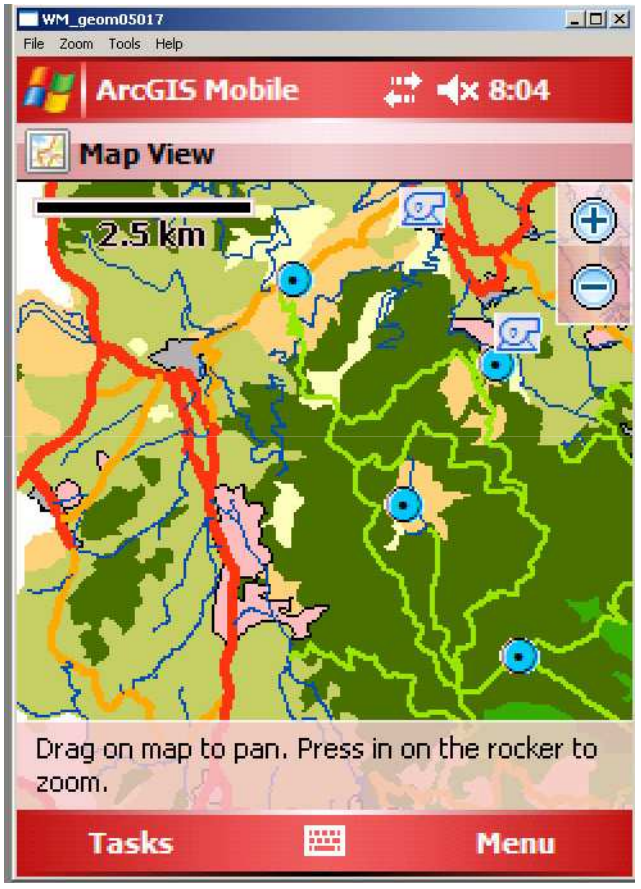
MOBILE GPS DATA NAVIGATION & MAPPING UTILITY





MOBILE GPS DATA COLLECTION UTILITY


They say that figures rule the world. I do not know if this is true, but I do know that figures tell us if it is well or poorly ruled.
—Goethe 1814, cited in UN Habitat 2001, 114
http://195.251.137.205/virtualfire
Questions?
ΕΥΧΑΡΙΣΤΩ