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Using Remote Sensing for Monitoring and Detecting the Fire Sources

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Abstract: In an effort to curb the phenomenon of "Dark Cloud", the Egyptian Ministry of State for Environmental Affairs resorted to the search for supportive solutions to this phenomenon using the modern technologies of "Remote Sensing" in the monitoring and tracking of rice straw fires, that helps identifying the burning locations in the Governorates of Delta. We have been relying on satellite images of the TERRA and AQUA satellites in locating burning at the Governorates of the Delta, these satellites were launched in 1998 and 1992 to complete research for the global agency NASA changes that take place in the hemisphere. The results were obtained to support the decision-makers in finding solutions that can be of assistance in getting rid of the phenomenon of the black cloud.

Keywords:

INTRODUCTION

Waste burning, Specific Problem (Burning of Agricultural and Burning of Municipal Waste):

Pollution from burning agricultural residues attracts little attention outside the September- January season. Within this period, rice straw, cotton stalks and fruit trees are harvested and their residues are burnt. Rice straw and cotton stalks are by far the most important contributors to pollution in Cairo at this time of year: fruit tree residues are burnt in many locations across Egypt; the burning of dry leaves from sugar cane over the period of December through May has far lower impact on air pollution in Cairo. These residues have been burned for decades without major complaints and the sugar cane plantations are located in Upper Egypt rather than in the Delta.

Remote sensing:

Remote sensing can be defined as the collection of data about an object from a distance. Humans and many other types of animals accomplish this task with aid of the eyes or by the sense of smell or hearing. Geographers use the technique of remote sensing to monitor or measure phenomena found in the Earth's lithosphere, biosphere, hydrosphere, and atmosphere. Remote sensing of the environment by geographers is

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Table: Rice Cultivated areas in Government during 2006.

Government	Cultivated area (Feddan)	Quantity of Straw (ton)	Quantity of Straw (%)
Kalyobia	36.000	72.000	2.43
Kafr El sheikh	271.469	542.938	17
Dakahlya	458.359	916.718	30
Beharia	216.178	432.356	14
Shakya	299.466	598.932	19
Gharbeya	181.122	362.244	12
Damitta	66.138	132.276	4
Fayoum	24.489	48.978	1.57
Total	1.553.221	3.106.442	100%

Table: Source Ministry of Agriculture Government that affecting Greater Cario

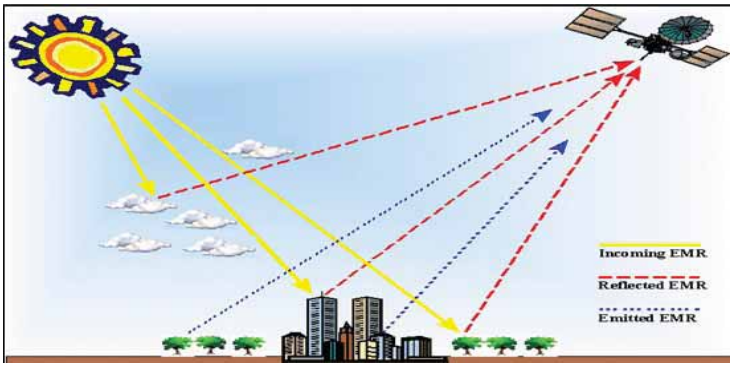
Region name	Wavelength	Comments
Gamma Ray	<0.03 nanometers	Entirely absorbed by the Earth 's atmosphere and not available for remote sensing.
X- Ray	0.03 to 30 nanometers	Entirely absorbed by the Earth 's atmosphere and not available for remote sensing.
Ultraviolet	0.03 to 0.4 micrometers	Wavelength from 0.03 to 0.3 micrometers absorbed by ozone in the Earth's atmosphere.
Photographic Ultraviolet	0.3 to 0.4 micrometers	Available for remote sensing the Earth. Can be imaged with photograph films.
Visible	0.4 to 0.7 micrometers	Available for remote sensing the Earth. Can be imaged with photograph films.
Infrared	0.7 to 100 micrometers	Available for remote sensing the Earth. Can be imaged with photograph films.
Reflected Infrared	0.7 to 3.0 micrometers	Available for remote sensing the Earth. Near Infrared 0.7 to 0.9 micrometers. Can be imaged with photographic film.
Thermel Infrared	3.0 to 14 micrometers	Available for remote sensing the Earth. This wavelength cannot be captured eith photographic film. Instead , mechanical sensor are used to image this wavelength band.
Microwave or Radar	0.1 to 100 centimeters	Longer wavelengths of this band con pass through clouds, fog, and rain. Images using this band can be made with sensors that actively emit microwaves.
Radio	> centimeters	Not normally used for remote sensing the Earth.

Table:

Platform	Lifetime(design)	Altitude	Equator Crossing	Sensors
Terra	1999-present(6 years)	705 km	10:30 a.m.	ASTERCERESMISRMODISMOPITT
Aqua	2002-presnt(6 years)	705 km	1:30 p.m.(ascending)	AIRS AMSR-E CERES MODIS

Table: Characteristics of the (Aqua & Terra Satellite Images)

Orbit:	705 km, 10:30 a.m. descending node (Terra) or 1:30 p.m. ascending node (Aqua), sun-synchronous, near-polar, circular
Scan Rate:	20.3 rpm, cross track
Swath Dimensions:	2330 km (cross track) by 10 degrees of latitude (along track at nadir)
Telescope:	17.78 cm diam. off-axis, afocal (collimated), with intermediate field stop
Size:	1.0 × 1.6 × 1.0 m
Weight:	228.7 kg
Power:	162.5 W (single orbit average)
Data Rate:	10.6 Mbps (peak daytime); 6.1 Mbps (orbital average)
Quantization:	12 bits
Spatial Resolution:	250 m (bands 1-2)500 m (bands 3-7)1000 m (bands 8-36)
Design Life:	6 years



usually done with the help of mechanical devices known as remote sensors. These gadgets have a greatly improved ability to receive and record information about an object without any physical contact. Often, these sensors are positioned away from the object of interest by using helicopters, planes, and satellites. Most sensing devices record information about an object by measuring an object's transmission of electromagnetic energy from reflecting and radiating surfaces.

Remote sensing imagery has many applications in mapping land-use and cover, agriculture, soils mapping, forestry, city planning, archaeological investigations, military observation, and geomorphological surveying, among other uses. For example, foresters use aerial photographs for preparing forest cover maps, locating possible access roads, and measuring quantities of trees harvested. Specialized photography using color infrared film has also been used to detect disease and insect damage in forest trees.

The simplest form of remote sensing uses photographic cameras to record information from visible or near infrared wavelengths (Table 2e-1). In the late 1800s, cameras were positioned above the Earth's surface in balloons or kites to take oblique aerial photographs of the landscape. During World War I, aerial photography played an important role in gathering information about the position and movements of enemy troops. These photographs were often taken from airplanes. After the war, civilian use of aerial photography from airplanes began with the systematic vertical imaging of large areas of Canada, the United States, and Europe. Many of these images were used to construct topographic and other types of reference maps of the natural and human-made features found on the Earth's surface.

Earth Observing System (EOS):

The Earth Observing System (EOS) is a major component of NASA's Earth-Sun System Missions. The mission includes a series of satellites, a science component, and a data system supporting a coordinated series of polar-orbiting and low inclination satellites for long-term global observations of the land surface, biosphere, solid Earth, atmosphere, and oceans. EOS is enabling an improved understanding of the Earth as an integrated system. The EOS Project Science Office (EOSPSO) is committed to bringing program information and resources to program scientists and the general public alike.

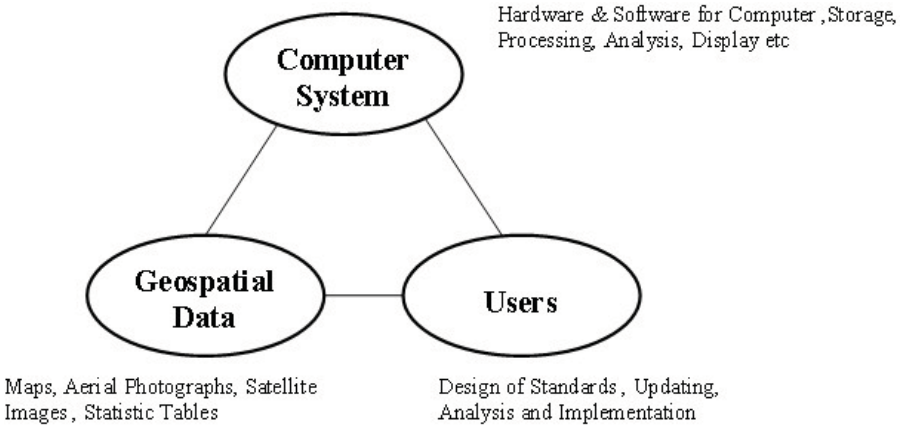


Fig. 1: Key component of GIS.

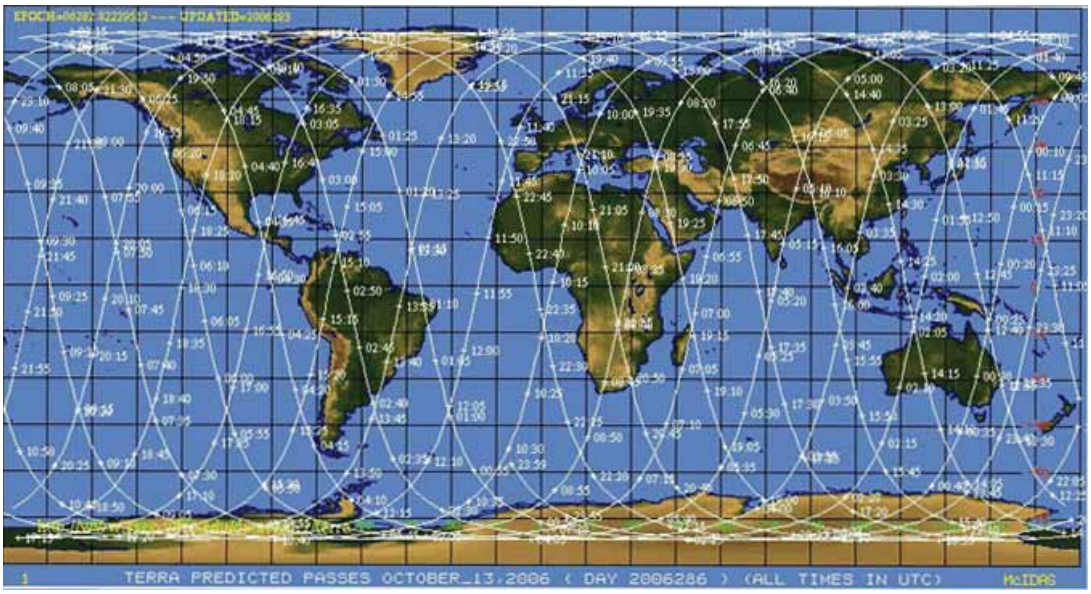
NASA Earth Observatory:

The purpose of NASA's Earth Observatory is to provide a freely-accessible publication on the Internet where the public can obtain new satellite imagery and scientific information about our home planet. The focus is on Earth's climate and environmental change. In particular, we hope our site is useful to public media and educators.

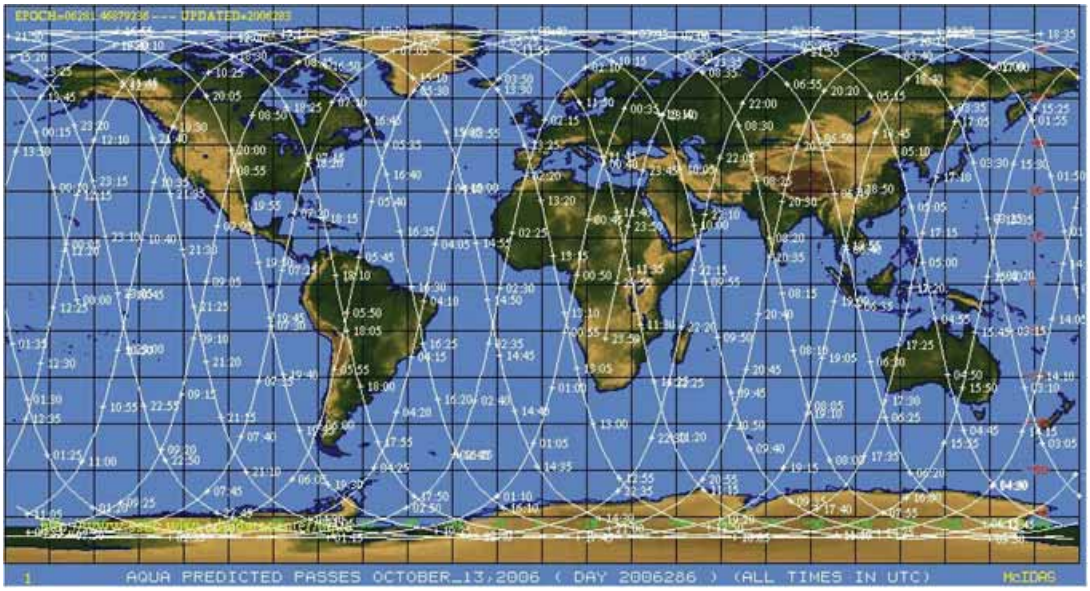
MODIS:

MODIS (or Moderate Resolution Imaging Spectroradiometer) is a key instrument aboard the Terra (EOS AM) and Aqua (EOS PM) satellites. Terra's orbit around the Earth is timed so that it passes from north to south across the equator in the morning, while Aqua passes south to north over the equator in the afternoon.

Terra Orbit



Aqua Orbit



Terra MODIS and Aqua MODIS are viewing the entire Earth's surface every 1 to 2 days, acquiring data in 36 spectral bands, or groups of wavelengths. These data will improve our understanding of global dynamics and processes occurring on the land, in the oceans, and in the lower atmosphere. MODIS is playing a vital role in the development of validated, global, interactive Earth system models able to predict global change accurately enough to assist policy makers in making sound decisions concerning the protection of our environment.

Modies Fire:

The MODIS fire and thermal anomalies products contain information unique to understanding the timing and spatial distribution of fires and characteristics such as the energy emitted from the fire and is available

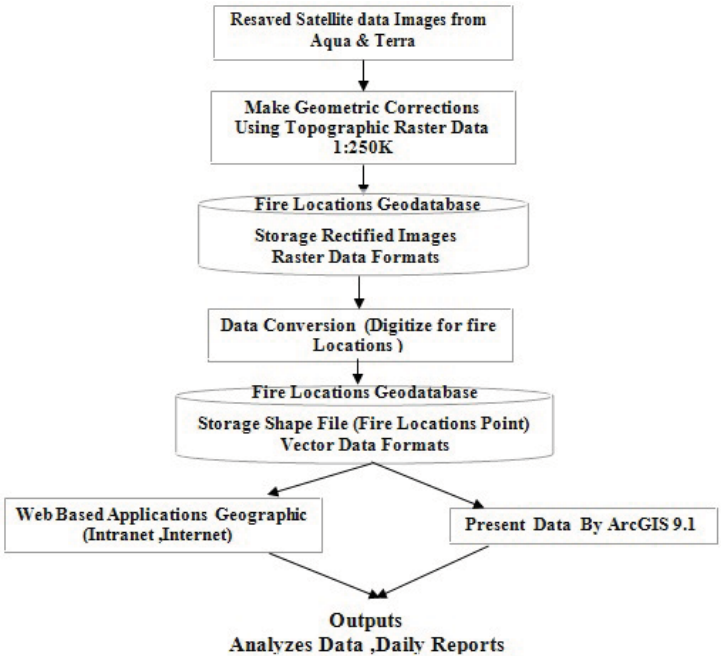
for both day and night periods. Temporal composites include an eight-day and monthly day and night fire occurrence aggregation and a summary of the number of fires in classes related to the strength of the fire. The MODIS Standard Fire products will provide an important contribution to the NASA Land Use and Land Cover Program and the International Global Observation of Forest Cover (GOFC) Project.

GIS Background:

The key components of GIS are a computer system, geospatial data and users, as shown in Figure.
A computer system for GIS consists of hardware, software and procedures designed to support the data capture, processing, analysis, modeling and display of geospatial data.

The sources of geospatial data are digitized maps, aerial photographs, satellite images, statistical tables and other related documents.

Geospatial data are classified into graphic data (or called geometric data) and attributes (or called thematic data). Graphic data has three elements ; point (or called node), line (or called arc) and area (or called polygon) in either vector or raster form which represent a geometry of topology, size, shape, position and orientation. The roles of the user are to select pertinent information, to set necessary standards, to design cost-efficient updating schemes, to analyze GIS outputs for relevant purpose and plan the implementation.



The GIS is needed due to the following Reasons?:

- Geospatial data are poorly maintained.
- Maps and statistics are out of date.
- Data and information are inaccurate.
- There is no data retrieval service.
- There is no data sharing.

Once a Gis Is Implemented, the Following Benefits Are Expected:

- Geospatial data are better maintained in a standard format
- Revision and updating are easier
- Geospatial data and information are easier to search, analyze and represent
- More value added product
- Geospatial data can be shared and exchanged Freely
- Productivity of the staff is improved and more efficient
- Time and money are saved- Better decisions can be made

MATERIALS AND METHODS

Data Used:
Raster Data:

- Satellite Images (Aqua &terra Satellite Images)
- Topographic Raster format (Scale 1:250K)

Vector Data:

- Egypt Base Map
- Governorate Boundaries
- Administrative Boundaries (Markz & Shiakh)
- GeadataBase (Fires Locations)

Software USED:

- ERDAS IMAGINE 8.7 (for Image Processing)
- ArcGIS 9.1(for create, edit, import, map, query, analyze)
- ArcIMS 9.1(for Building Web Based Geographic Applications)
- Internet Explorer

Hardware USED:

- Processor: Intel P 4 (Hyper Technology 3.4G).
- Server (DELL)
- Network Connections
- Printers (Hp)
- Scanner (Vidar)

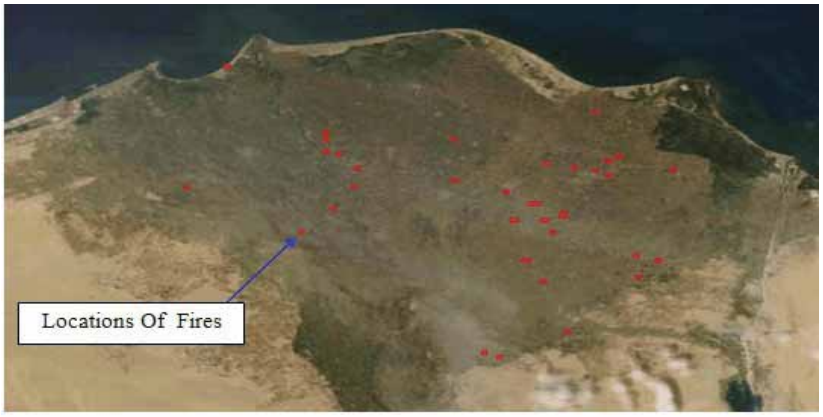
Technique:

- Received Data of the Terra & Aqua Satellite Images

Terra Satellite Image Band Combinations : 1-4-3 True Color

Pixel Size : 500M Date : 10-9-2006

Time : 8.50 UTC Coordinate System: Un Rectify



Aqua Satellite Image Band Combinations : 1-4-3 True Color

Pixel Size : 500M Date : 10-10-2006

Time : 11:10 UTC Coordinate System: Un Rectify

– Deflations (Aqua & Terra Satellite Images)

Aqua is one of the major satellite missions of the US National Aeronautics and Space Administration (NASA)'s Earth Observing System (EOS). The Aqua satellite was launched on May 4, 2002. It is a sister of the EOS Terra satellite previously launched on December 18, 1999. Both satellites are operated in a sun-synchronous orbit at an altitude of 705km with the Aqua spacecraft crossing the equator at about 1:30 pm (local time, descending southward) and the Terra spacecraft crossing the equator at 10:30 am (local time, ascending northward). There are five Earth-observing instruments onboard the EOS Terra platform and six onboard the Aqua. The MODerate Resolution Imaging Spectroradiometer (MODIS) is one of the key instruments of the NASA EOS and is currently operating onboard both the Terra and Aqua satellites1-4. MODIS is a scanning radiometer with 36 spectral bands that cover wavelengths from 0.41 micrometer to 14.2 micrometers, making measurements at three nadir spatial resolutions: 250m, 500m and 1km. It has a field of view (FOV) of ±55o from the instrument nadir, resulting in a swath of 10km (at nadir) along track by 2330km cross track during each scan of 1.47 seconds. Both Terra and Aqua MODIS are able to provide near global coverage in 2 days. Working together, the two MODIS instruments can view the same Earth scene with complementing morning and afternoon observations, thus providing diurnal information on many of the parameters for the long-term studies of the climate, weather, and environmental changes3, 5-8. The Aqua MODIS started its Earth scene observations on June 24, 2002 (aka first light) when the nadir aperture door (NAD) was opened. Except for a few spacecraft safe-hold events during its check out period (launch + 120 days) that resulted in small response changes and minor data gaps, theAqua MODIS instrument has been operating continuously and producing calibrated data sets for use by the scientific research community.

Geomantic Corrections:

The steps to follow for geometric correction are as follows

(1) transform formula: polynomials $x = \Sigma\Sigma a_{ij}\ u^{i-1}\ v^{j-1}$

(2) Parameters of geometric corrections $y = \Sigma\Sigma b_{ij}\ u^{i-1}\ v^{j-1}$

- Un rectify Image To Rectify Topographic Raster Map(250K)
- set projection (Egyptian Transverse Mercator - Red Belt)

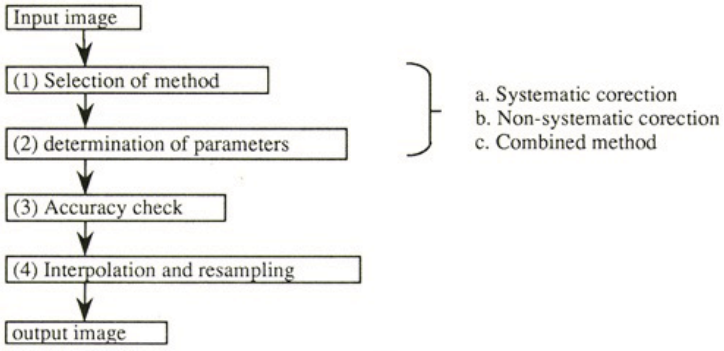
(3) Accuracy Check : The distribution of GCP's should be random, but almost equally spaced including corner areas

(4) Interpolations and Resampling, Nearest neighbor (NN) Output Image (Aqua & Terra Rectify Image)

(5) change Projection

: Egyptian Transverse Mercator (Red Belt)

: Geographic (Old Egyptian 1907)



Input Image (Aqua & Terra Un Rectify Image)

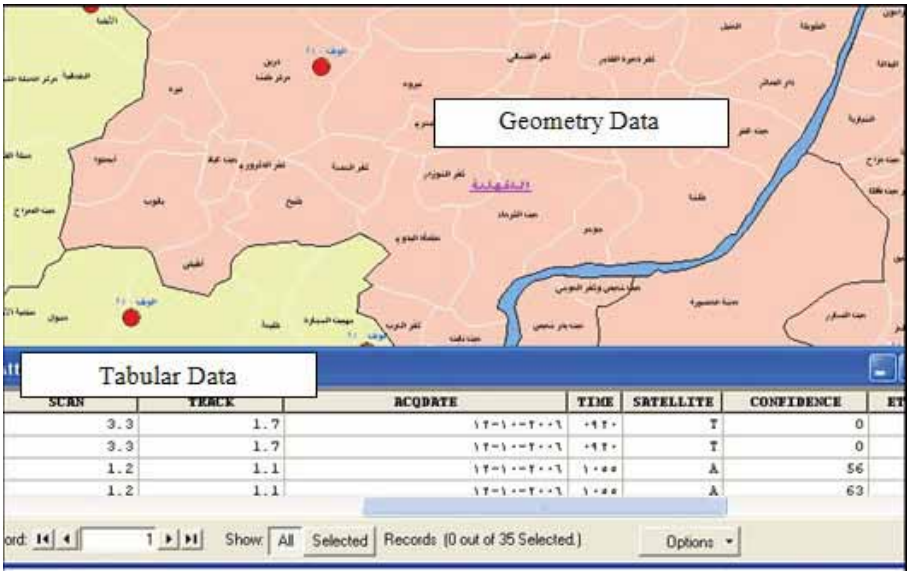
Data Conversion (Raster to Vector):

After Images has been Rectified Using ERDAS IMAGINE 8.7. start to digitizing the fires locations

Import a Tabular& Geospatial Data into the Fire Location:

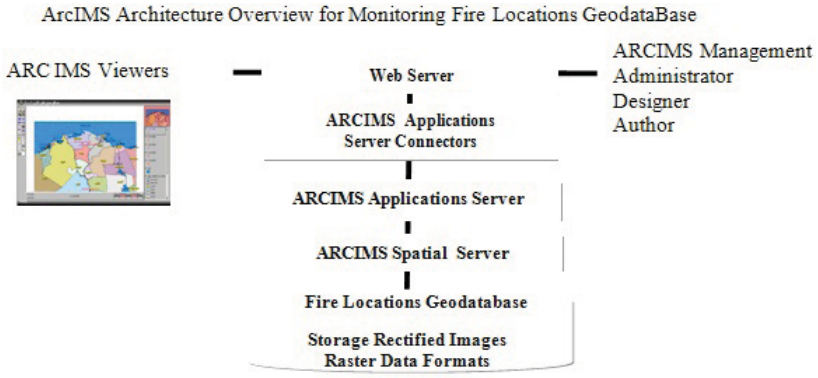
Geo DataBase:

- Governorate Boundaries
- Administrative Boundaries (Markz & Shiakh)
- Rectified satellite Images (Aqua & Terra) every day
- Vector Data (shape Points) Locations Fires has been digitized



Creating A geographic Website Based A Geographic Application Using ArcIms9.x:

ArcIMS is a server-based product that provides a scalable framework for distributing GIS services and data over the Web. ArcIMS provides Web publishing of GIS maps, data, and metadata for access by many users both inside the organization and outside on the World Wide Web. ArcIMS enables Web sites to serve GIS data, interactive maps, metadata catalogs, and focused GIS applications. ArcIMS users access these services through their Web browsers using HTML or Java applications that are included with ArcIMS. In addition, ArcIMS services can be accessed using many different clients including ArcGIS Desktop, ArcIMS Architecture Overview for Monitoring Fire Locations GeodataBase

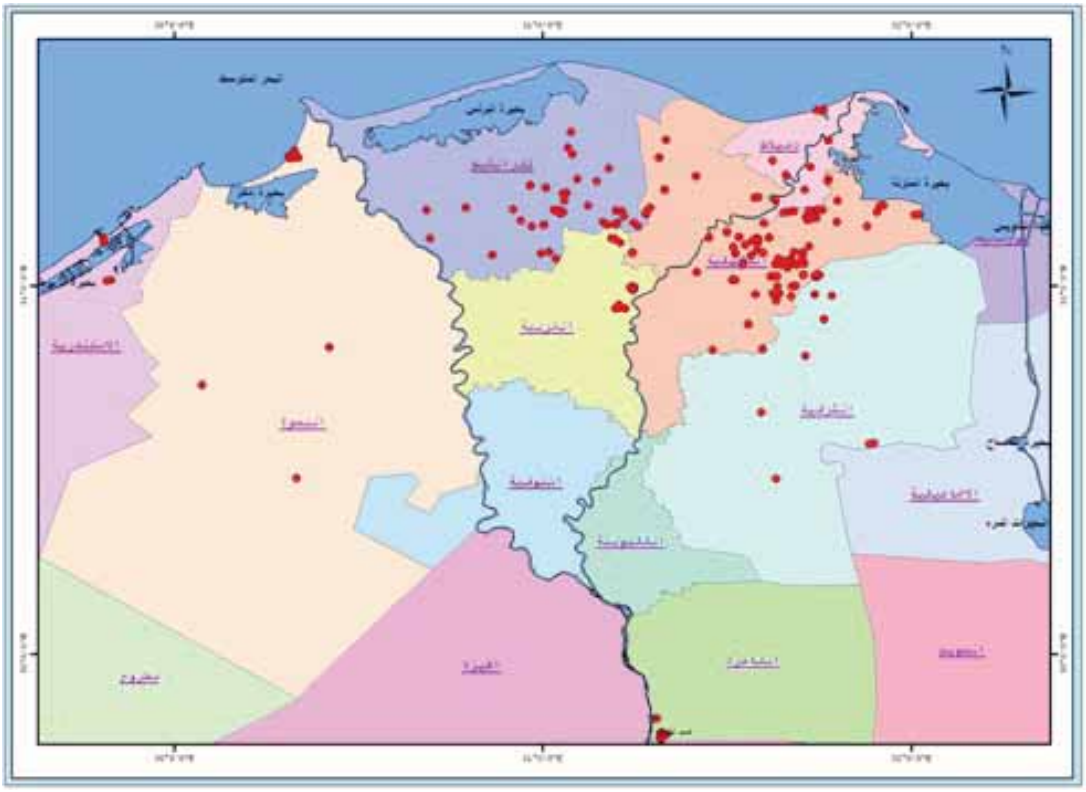


RESULTS AND DISCUSSIONS

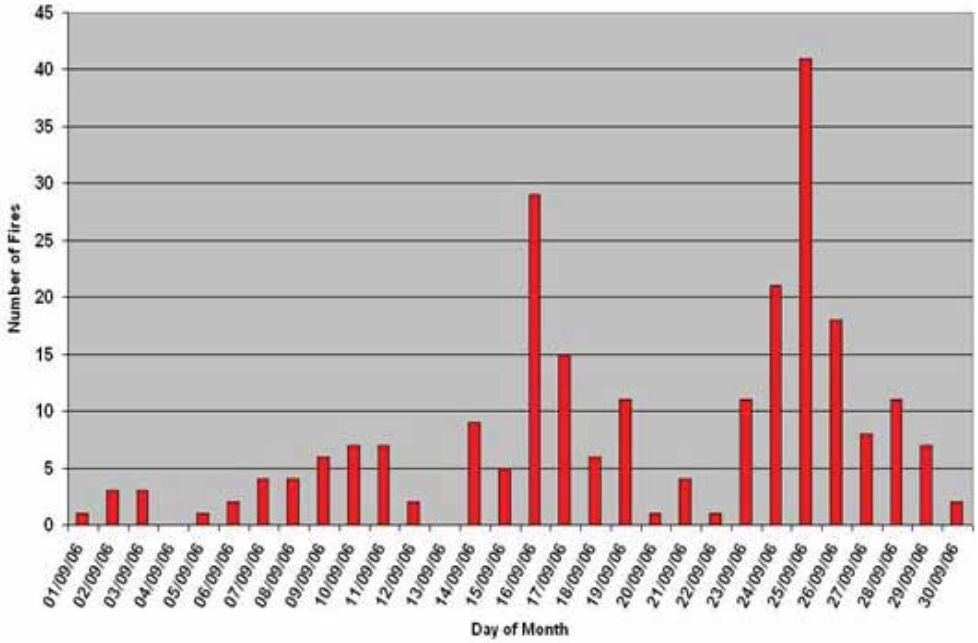
Results and Discussions Analysis and Monitoring:

Each of these fire maps accumulates the locations of the fires detected by MODIS on board the Terra and Aqua satellites over a day period as shown. Each colored dot indicates a location where MODIS detected at least one fire.

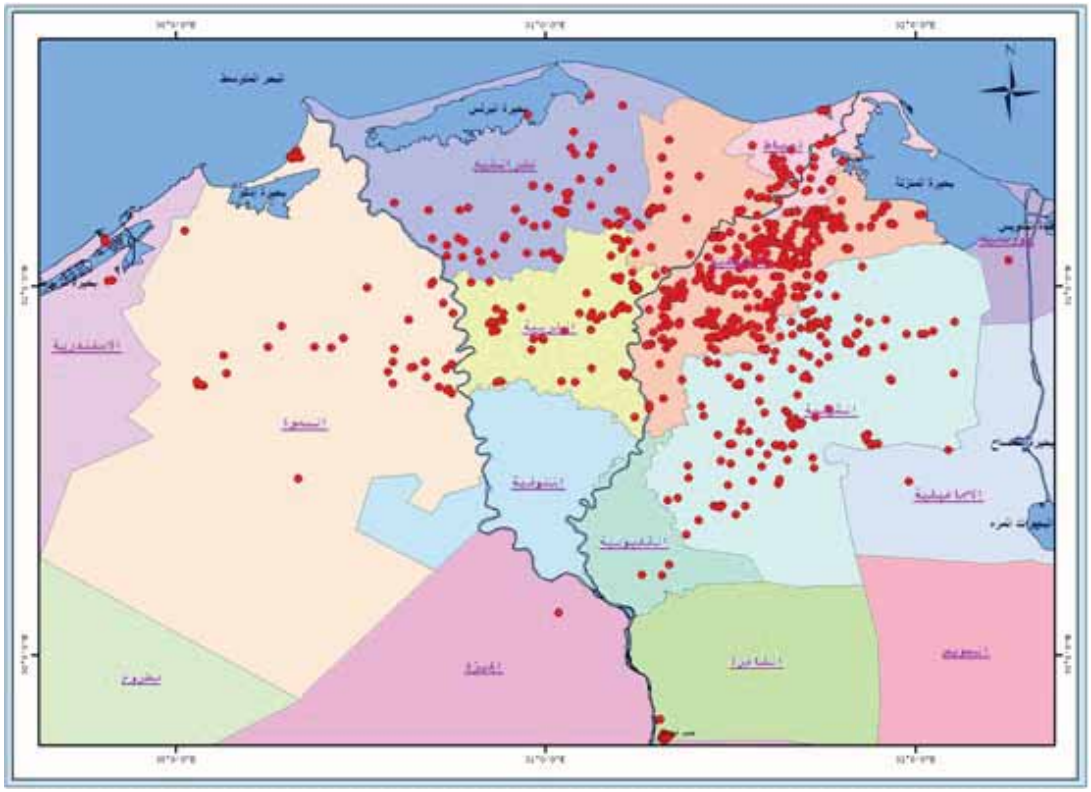
- The Map Shows The Concentrations Of Rice Straw Fires Locations At the Governorates Level During The Month Of September 2006



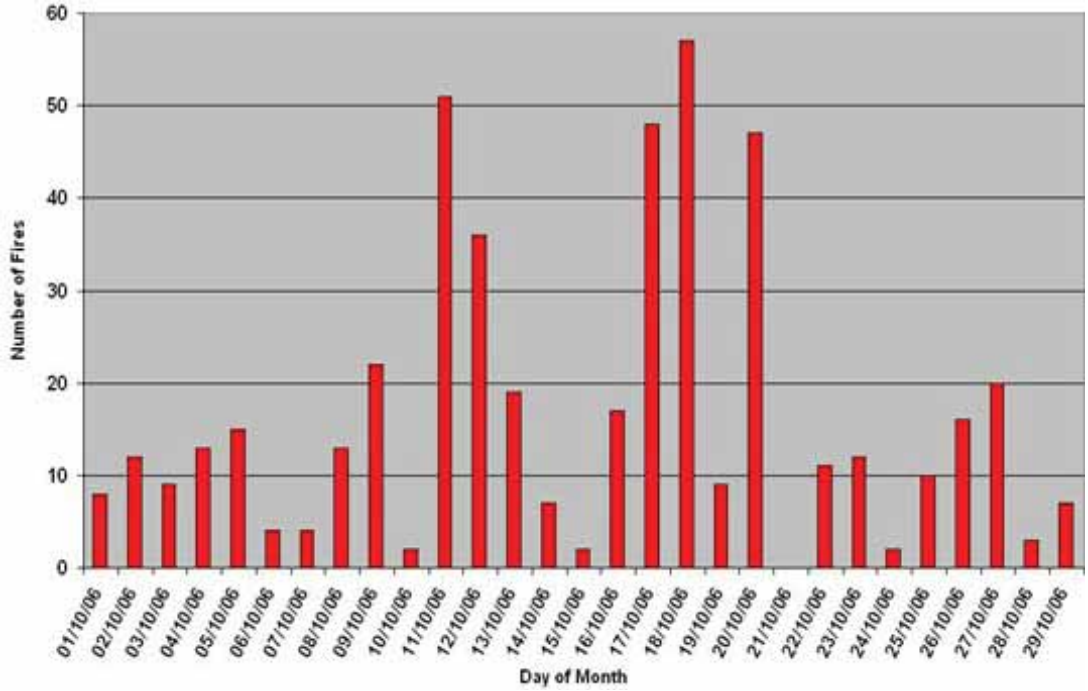
- The Chart Shows The Fires Locations of Rice Straw Sites During The Days of September 2006



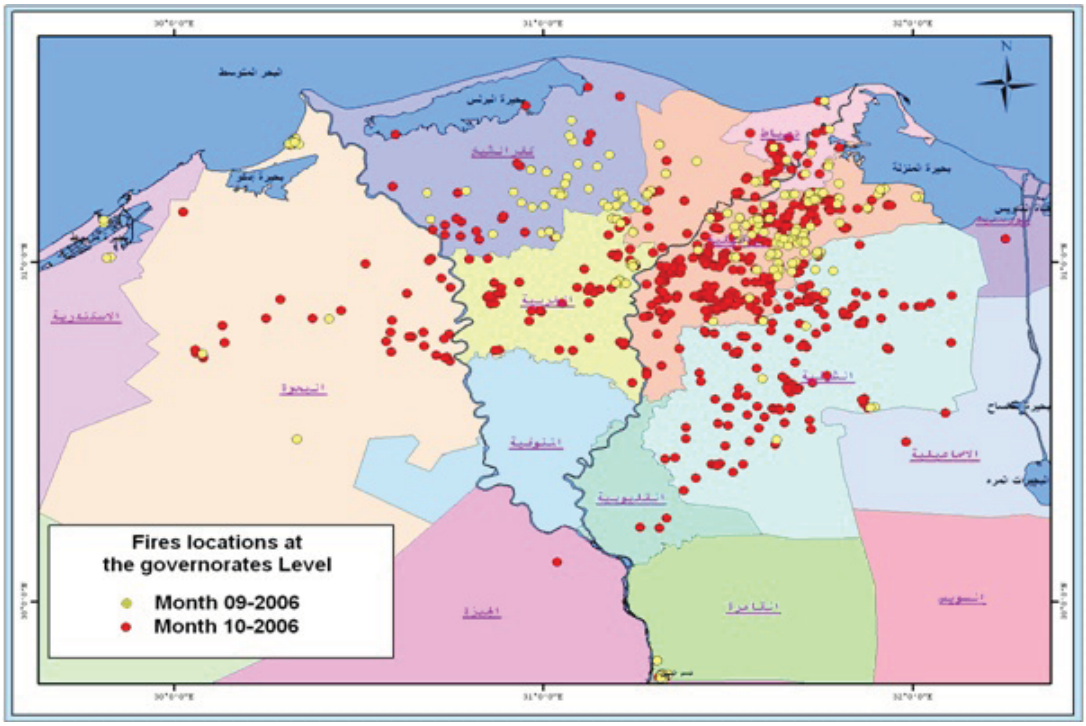
- The Map Shows The Concentrations of Rice Straw Fires Locations At the Governorates Level During The Month of October 2006



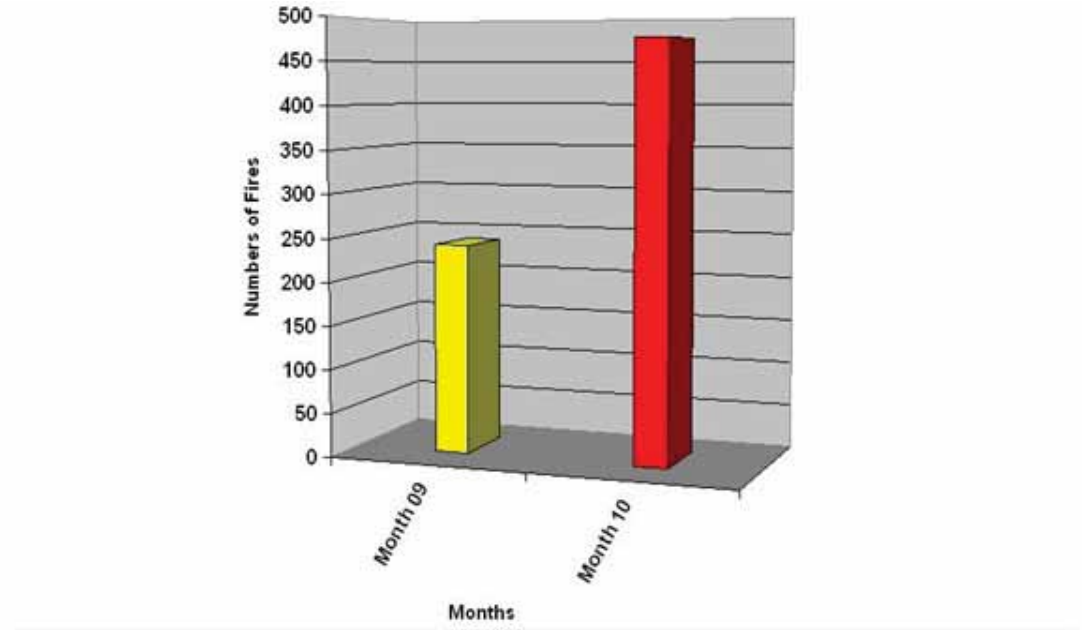
- The Chart Shows The Fires Locations Of Rice Straw Sites During The Days of October 2006



- The Map Shows the Difference Between the Concentrations of Fires Locations of Rice Straw in September and October.



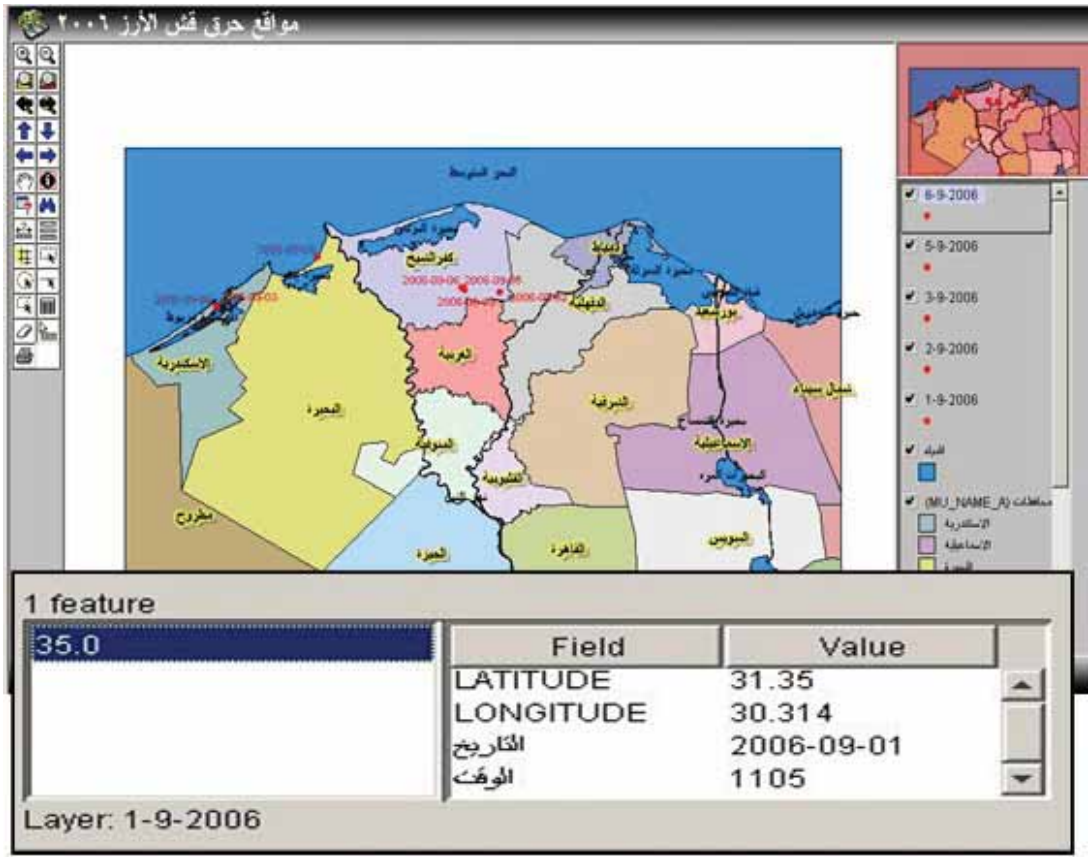
- The Chart shows the difference between the total rice straw fires during the months of September and October



Month 09		Month 10	
T.Numbers	240	T.Numbers	476

Geographic Website Based:

Which Had Been Established Specifically For The Management Of Receiving Data From Aqua And Terra Satellites.



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