# INTEGRATED REMOTE SENSING AND GIS TECHNIQUES FOR IMPROVING TRANSBOUNDARY WATER MANAGEMENT: THE CASE OF PRESPA REGION

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# When writing the paper on the application of "Integrated Remote Sensing and GIS Techniques on Transboundary Waters", we ended up with a discussion of results…

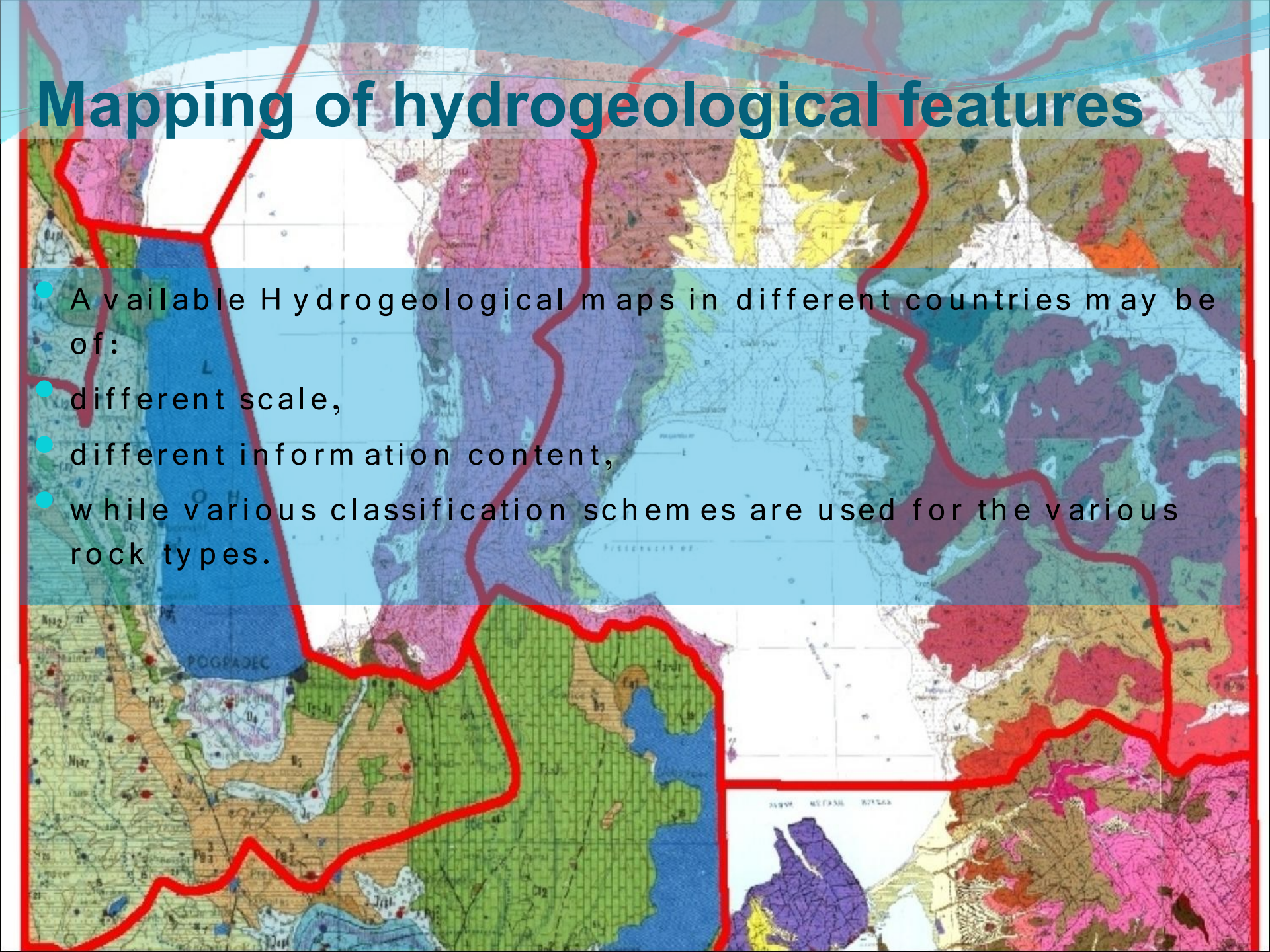
- **I shall start the presentation with this discussion which can be summarized as following:**
- Remote sensing provides information concerning different hydrological parameters of interest to a transnational river /lake basin assessment project
- Monitoring is supported due to the multi-temporal character of the data,
- Water quantity /quality assessments can be performed while these can be integrated within a GIS system,
- The methodology is cost effective,
- Exchange and protection of information, as well as public access to information is supported.

# Techniques is well established on various "environmental" projects. What are the benefits for applying such techniques when managing Transnational hydrologic basins?

- **Water resource management requires:** sufficient, long-term, frequent and reliable data which cover different types of environmental /water quantity /water quality data…

- Remote Sensing can contribute by supporting activities like:
- Mapping hydrological /hydrogeological features of interest / Land cover changes, &
- Providing parameters related to water quantity & water quality.

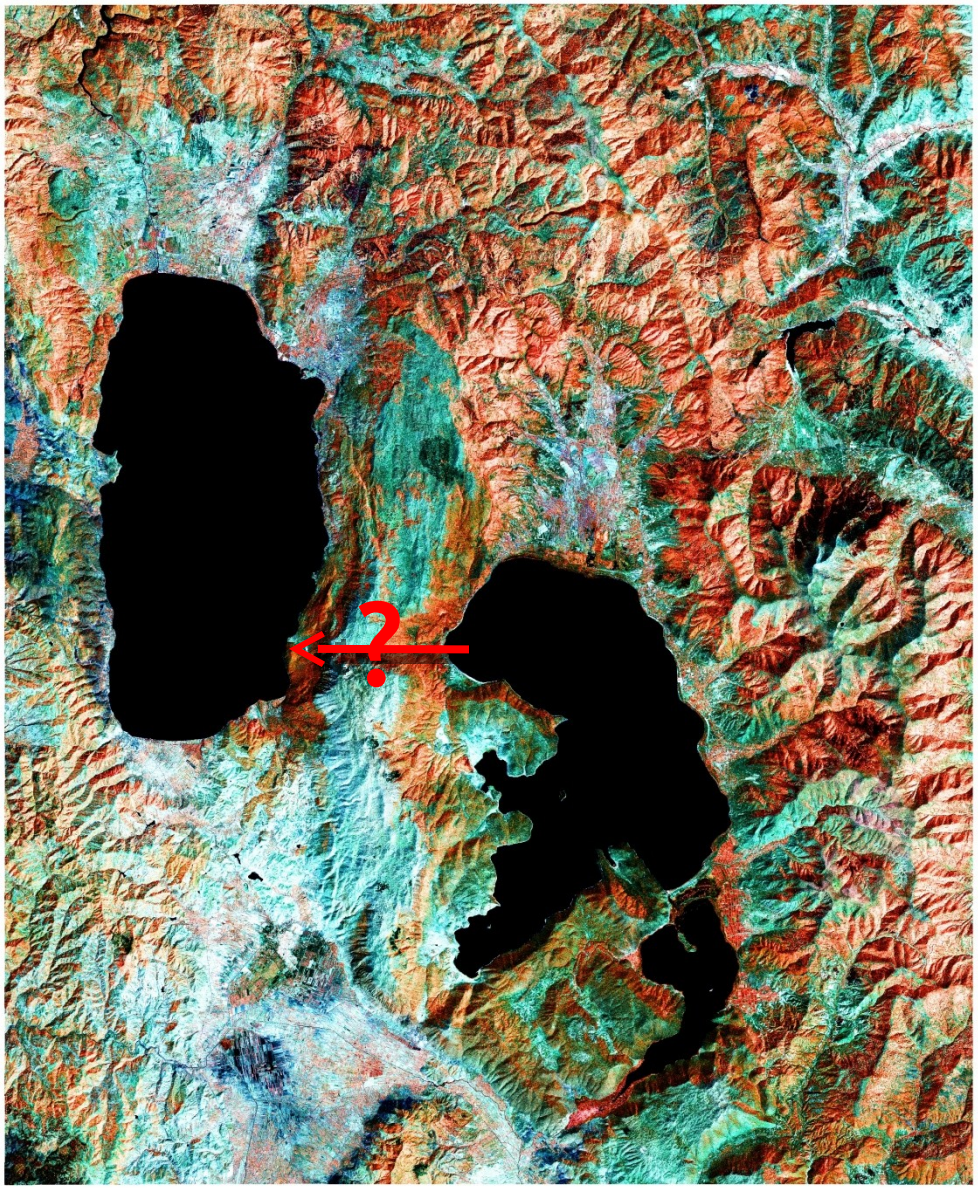
# Mapping of hydrogeological features



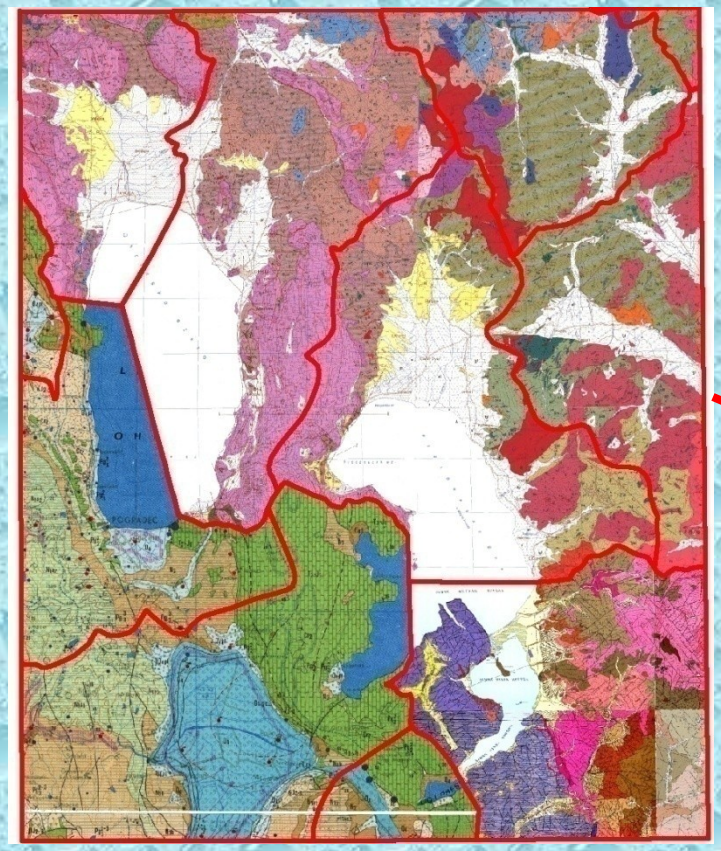
- Available Hydrogeological maps in different countries may be of:
- different scale,
- different information content,
- while various classification schemes are used for the various rock types.

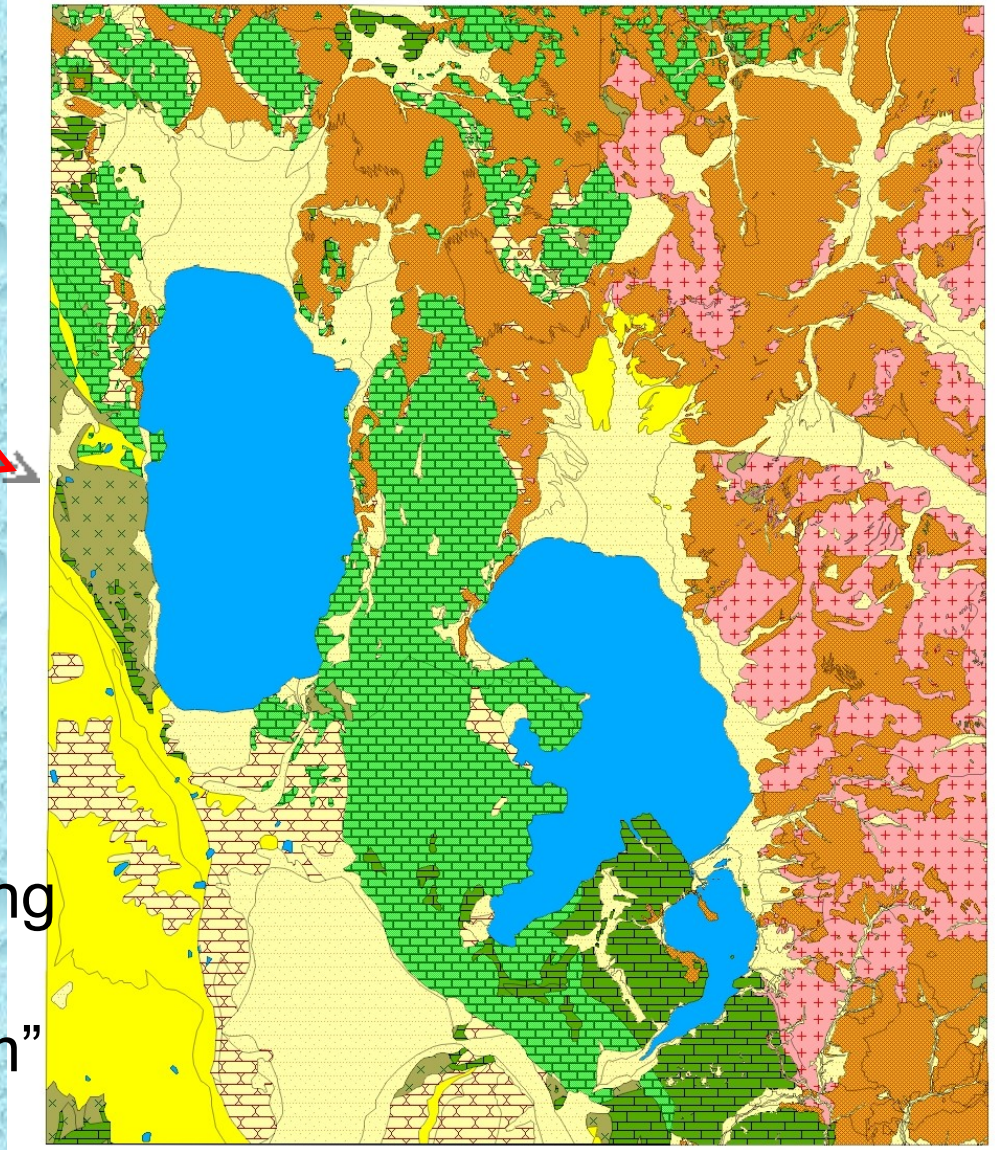
# Mapping of hydrogeological features


? Missing tectonic lines



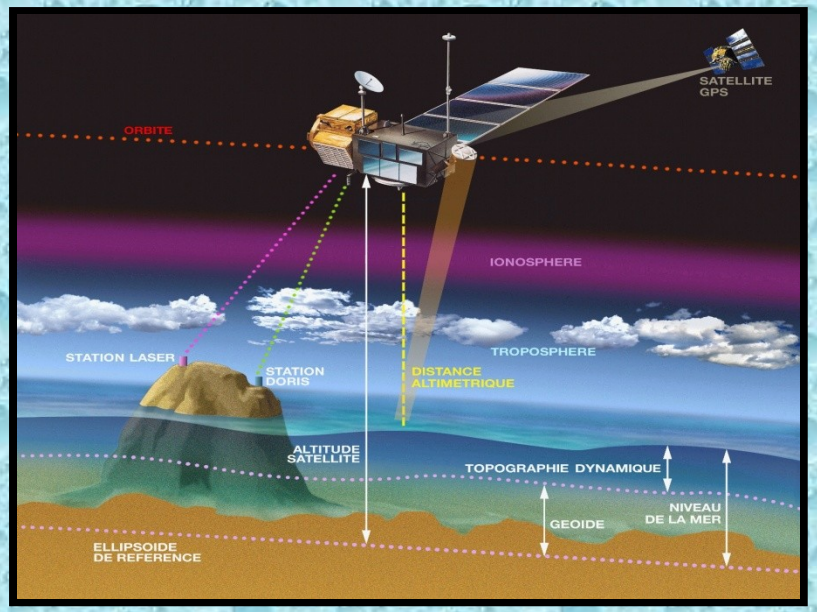
# Update the hydrogeological maps





Integrated use of remote sensing
and GIS techniques
can be used to make a “unifrom”
hydrogeological map

# Hydrology from Space




## RADAR ALTIMETRY MEASUREMENTS

T/P (Oct 1992-Aug 2002, new orbit -Aug 2002-2005)

Jason-1 (since Feb 2002)

GFO (since Jan 2000)

ENVISAT (since Nov 2002)

*+ ERS-1 (Jul 1991 - Mar 2000), ERS-2 (since Apr 1995)*

MAIN INSTRUMENTS: RADAR ALTIMETER, RADIOMETER

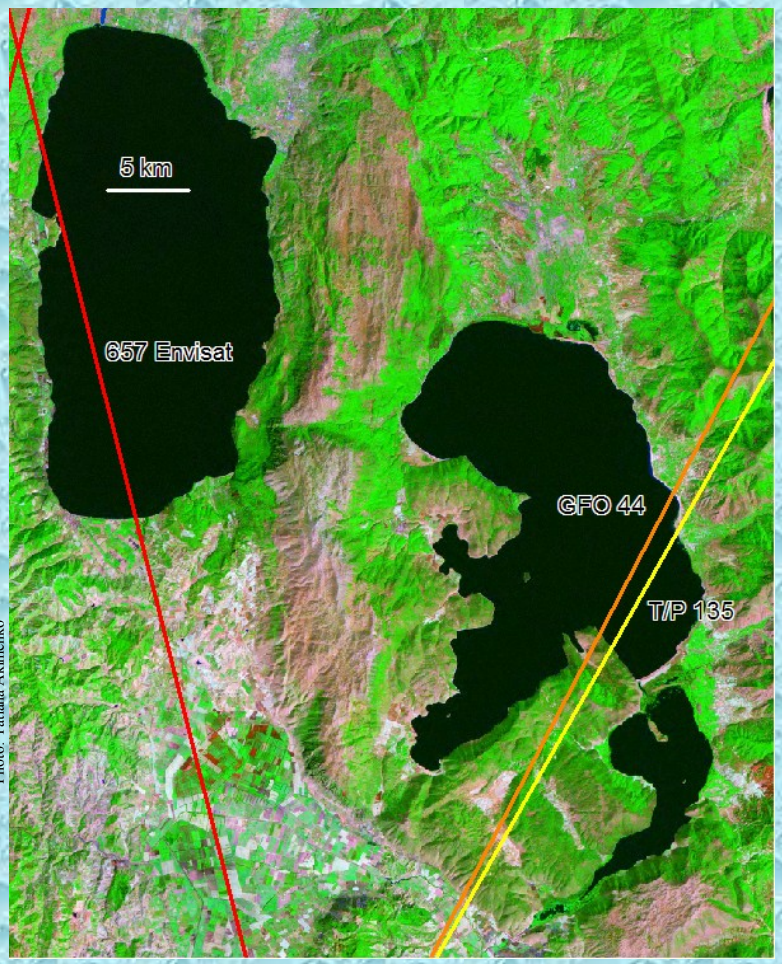
REPEAT PERIOD: 10 days (T/P, Jason), 17 days (GFO) and 35 (ENVISAT)

Since 2002 -

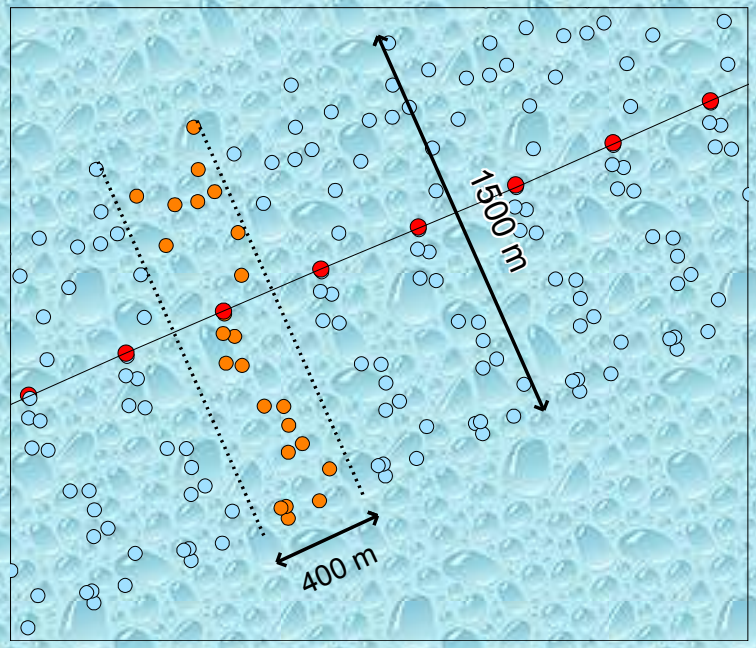
Three satellites

# Hydrology from Space

Photo: Tatiana Akimenko




## WATER LEVEL FROM SPACE

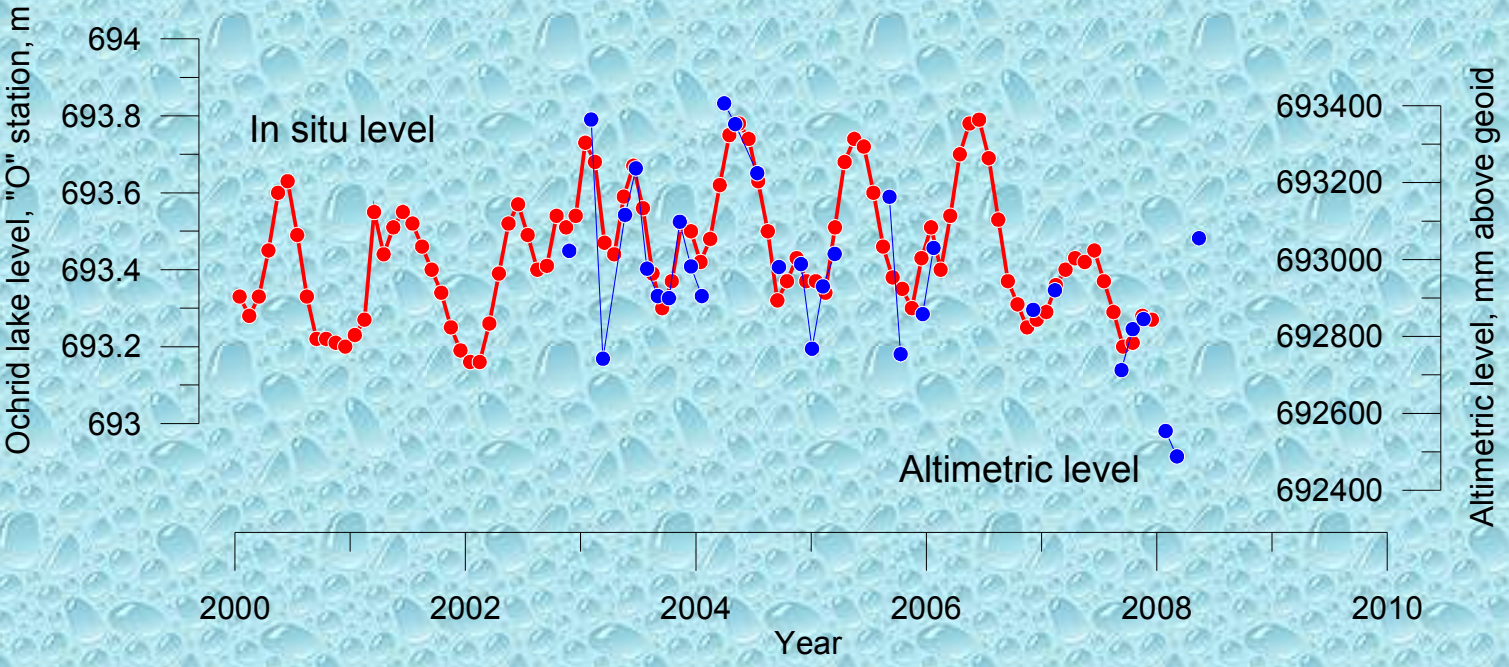



*Overview Red line - ENVISAT track, Orange - GFO and yellow - T/P*
*Sample of spatial distribution of 18 Hz Envisat measures*

# Hydrology from Space

## WATER LEVEL / VOLUME

Lake level from in situ and altimetric data.

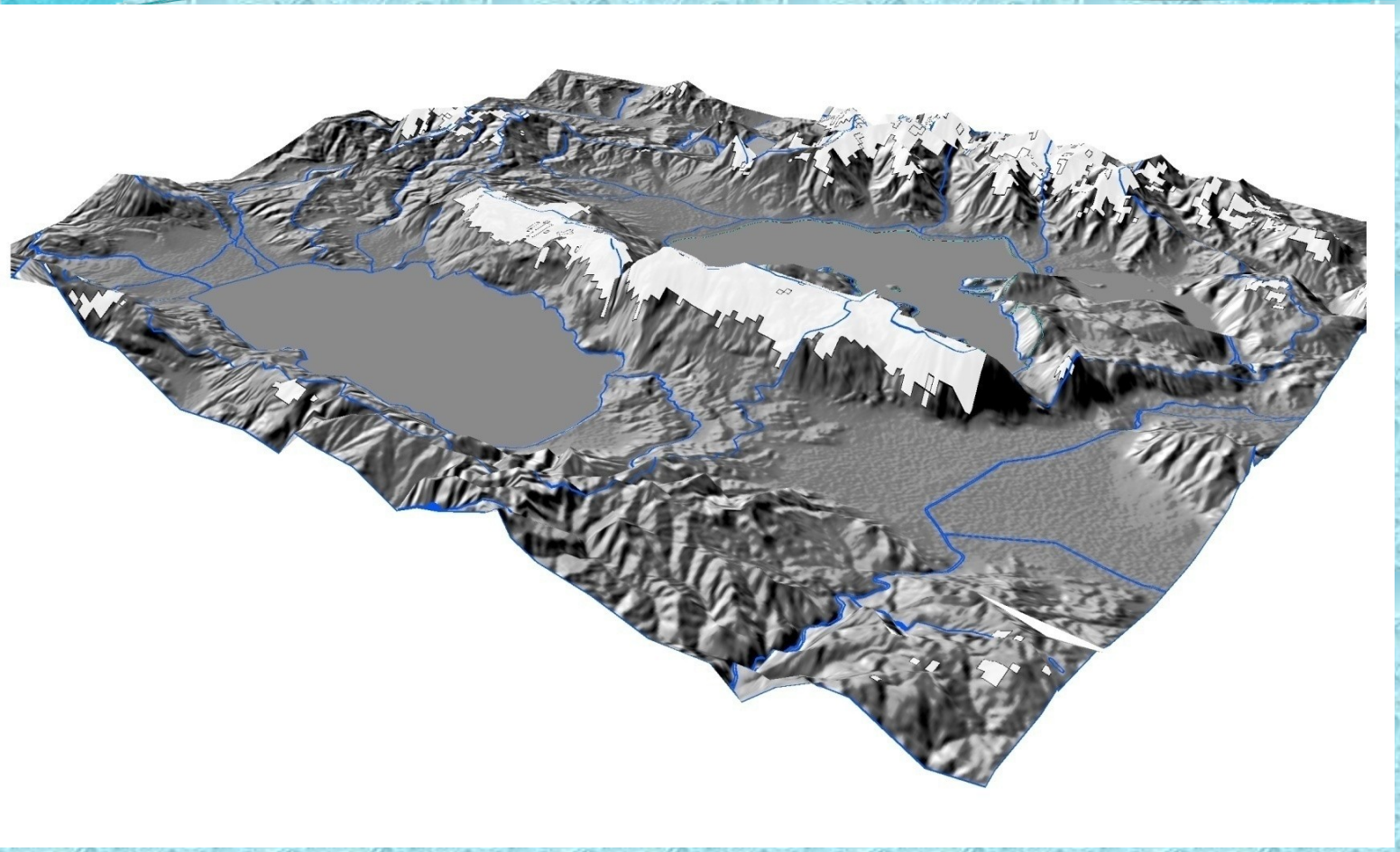



*In situ (red line and dots) and altimetric (blue line and dots) water level time series*

Possibility to reconstruct and monitor water level time series for Ochrid (ENVISAT) and Macro Prespa (GFO + T/P new orbit) lakes.

Estimation of lake volume changes.

# Hydrology from Space Other possibilities



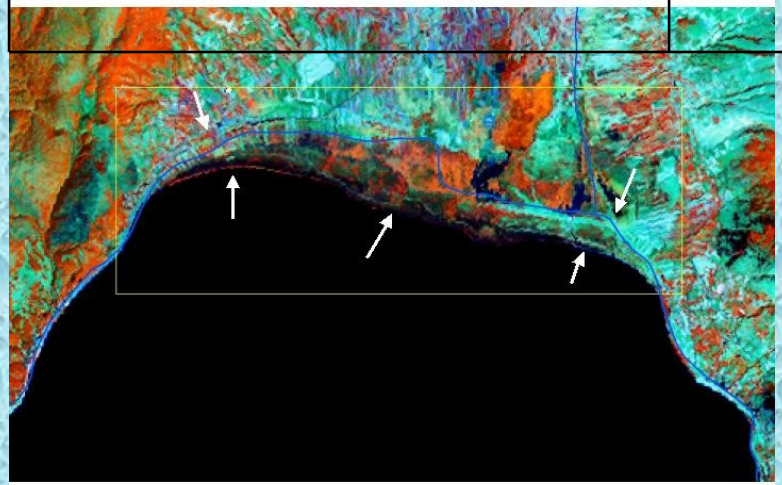
Snow cover

Snow extent and depth from passive microwave data SSM/I (625 $km^2$) AMSR-E (156 $km^2$), and simultaneous passive and active microwave (altimeters). Water and snow extent from optical imagery (MODIS /MERIS, Landsat, ASTER, SPOT...SMOS Soil moisture

# Hydrology from Space Other possibilities

## Lake Water extent: Change analysis

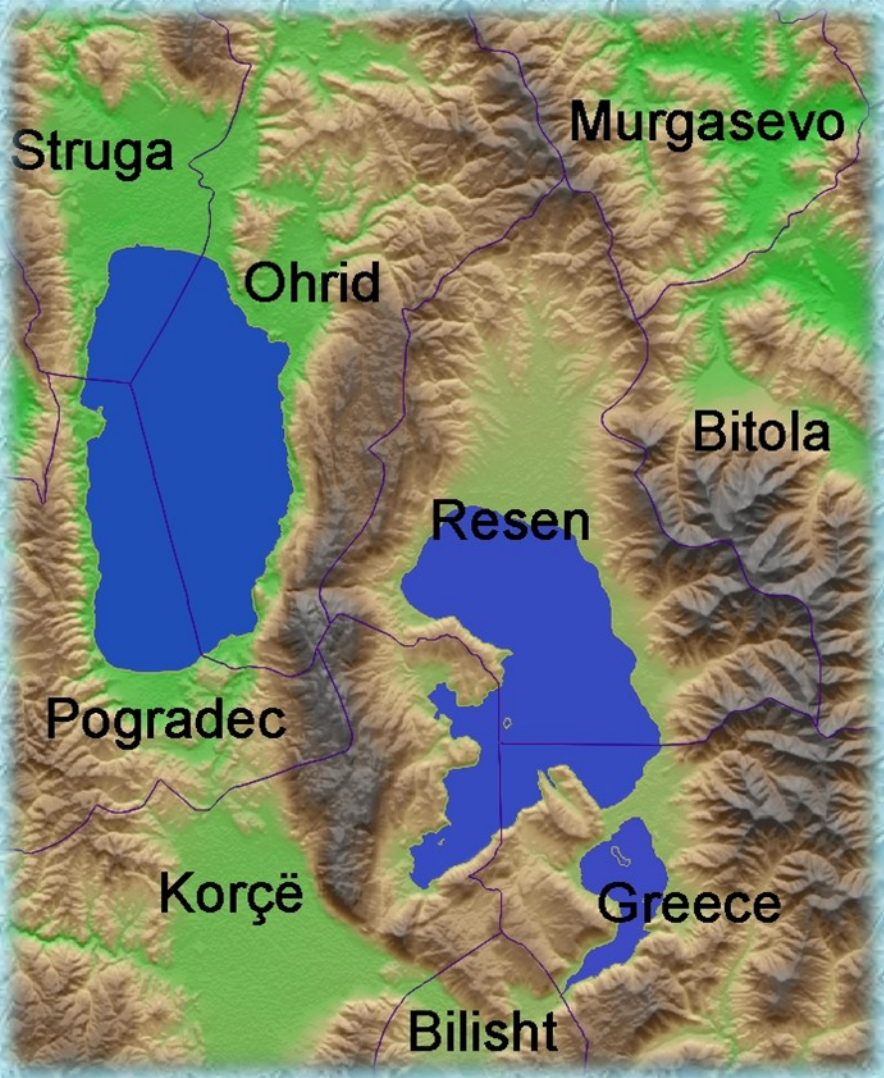
| DATES | Water Level August (m) | Water Level Mean annual (m) | SurfaceArea km² (satellite data) |
|---|---|---|---|
| 1978 (Landsat MSS image) | 849.33 | 849.32 (1977-1978) | ~276 |
| 1988 (Landsat TM image) | 849.08 | 849.48 (1987-1988) | 273.70 |
| 2000 (Landsat ETM image) | 845.36 | 845.78 | 265.26 |
| DIFFERENCE 1978 to 2000 | | 3.54 | 10.74 |



Shrinking of Prespa Lake, would have an impact on the wetlands of the region… .

# Hydrology from Space Other possibilities

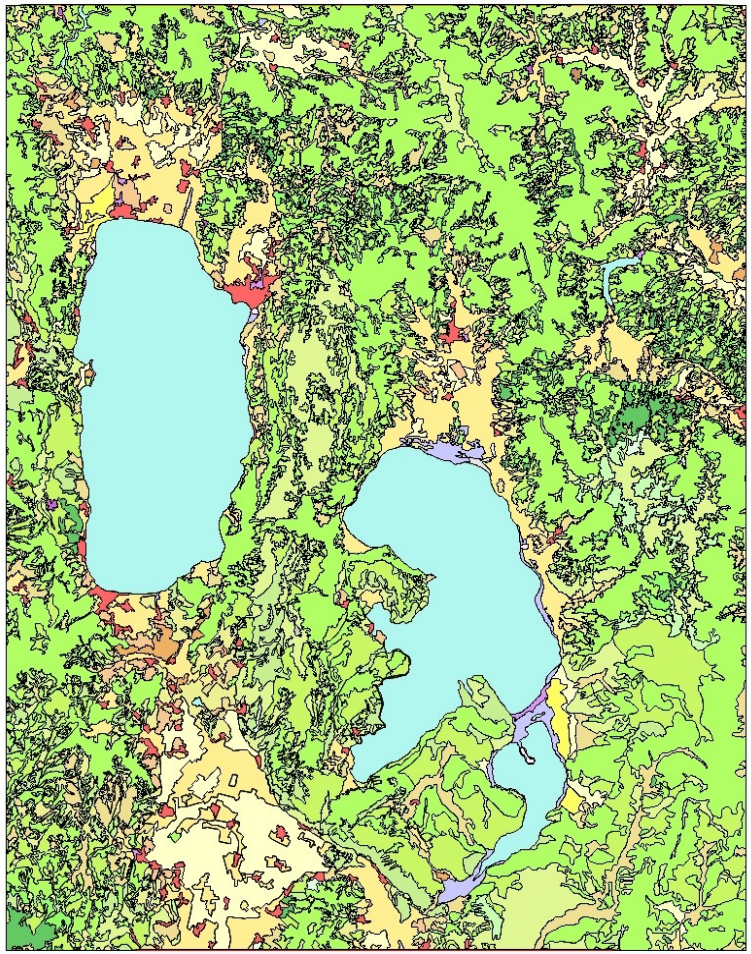
## Digital Terrain Models




Construction of Digital Terrain Models using stereo imagery or after the application of GIS techniques.

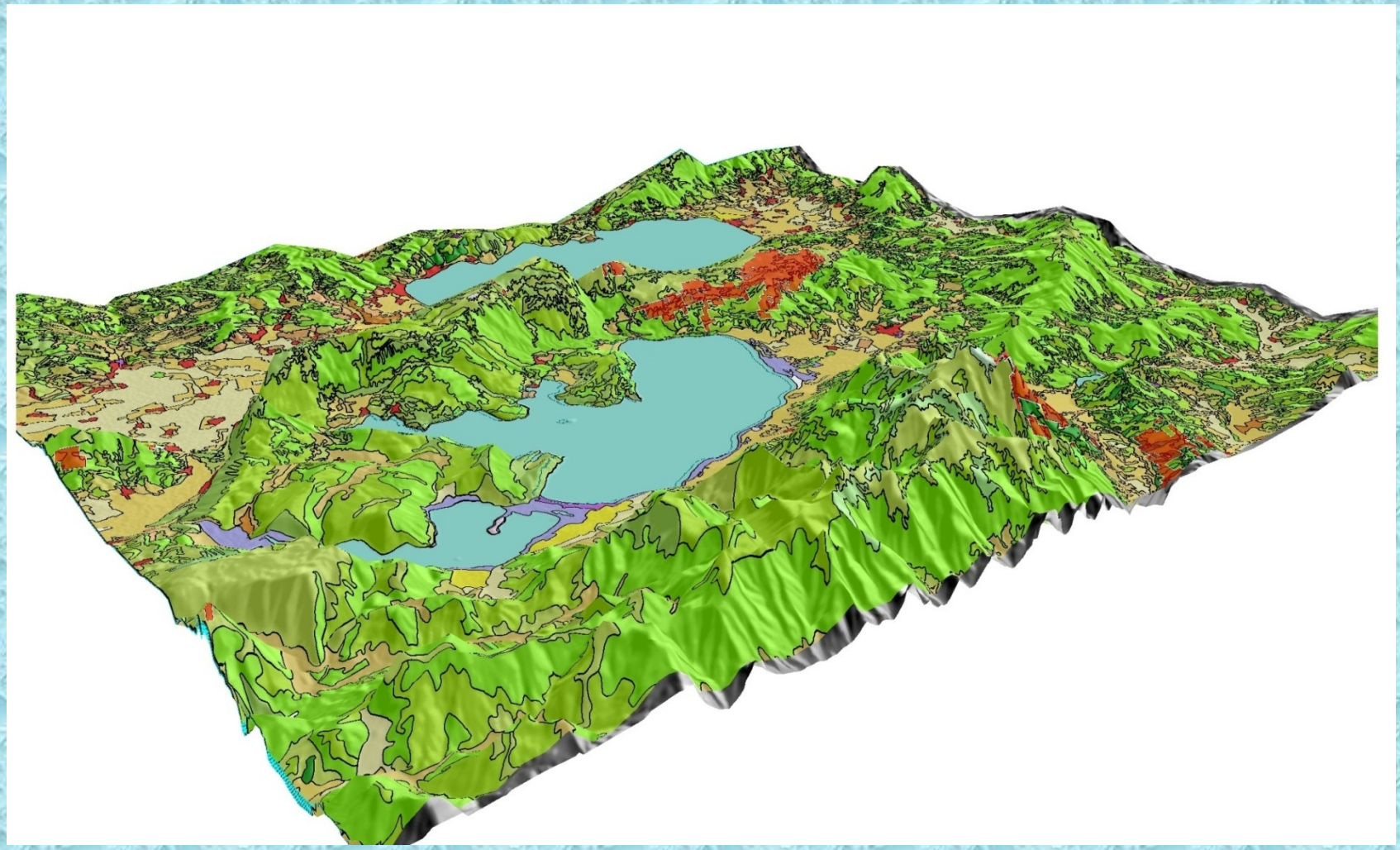
The pilot study area is quite mountainous and it includes the Micro / Macro Prespa lakes at an altitude of 850 meters and Ochrid lake at an altitude of 695 m a.m.s.l.

# Hydrology from Space: Update Land Cover maps Monitor spatial & temporal changes…



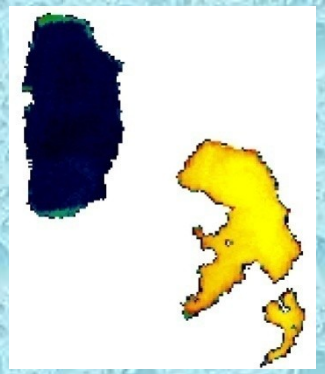
- Pollution loads vary with the various types of land cover.
- Coniferous forests have higher filtering capacities for atmospheric deposition than deciduous forests,
- Type and rate of application of fertilizers and pesticides vary with each crop type,
- Land cover affects precipitation surplus and consequently the concentration of pollutants

# Hydrology from Space: Update Land Cover maps Monitor spatial & temporal changes…

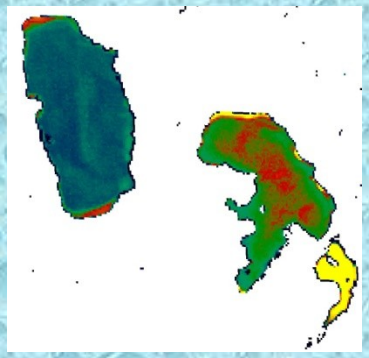


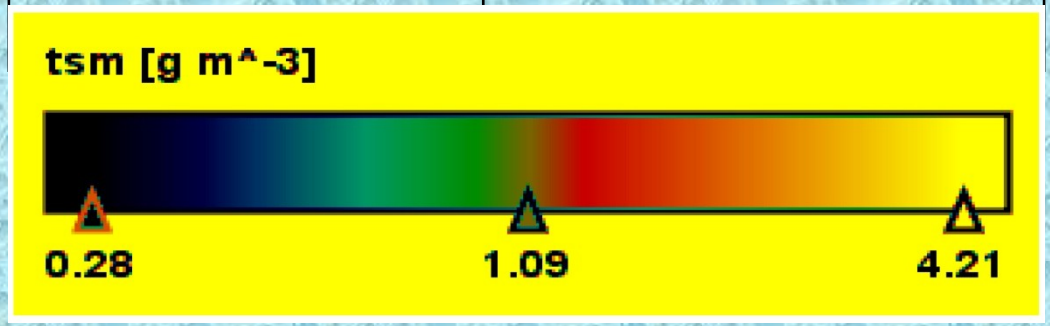
Land cover changes that influence hydrologic infiltration parameters of water basins, due to fire events can be detected using MERIS data…They can be used for monitoring the area on a continuous basis and also for map updating procedures in the GIS system.

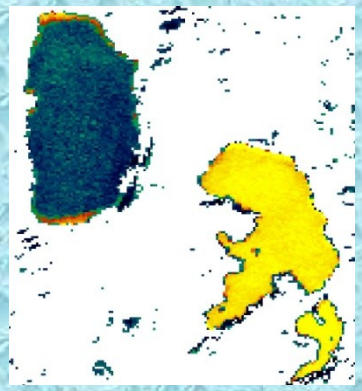
# Hydrology from Space: Monitor spatial & temporal changes of water quality…

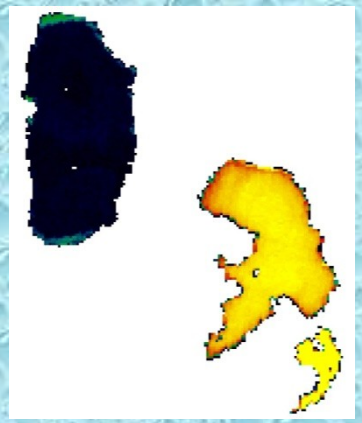


| | |
|---|---|
| **A** TSM [g m^]$^{-3}$ 0.27 to 4.5 : 21 / 8 / 2007 | **B** TSM [g m^$^{-3}$] 0.17 to 3.37:15/02/ 2008 |
| **C** TSM [g m^]$^{-3}$ 0.19 to 3.25 : 1/ 5/ 2008 | **D** TSM [g m^]$^{-3}$ 0.28 to 4.21 : 15 / 8 / 2008 |



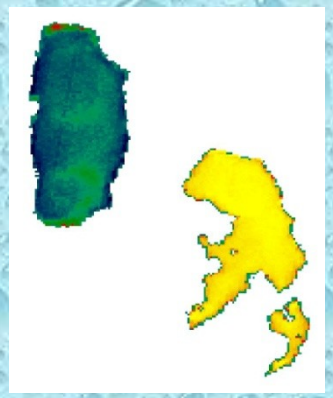


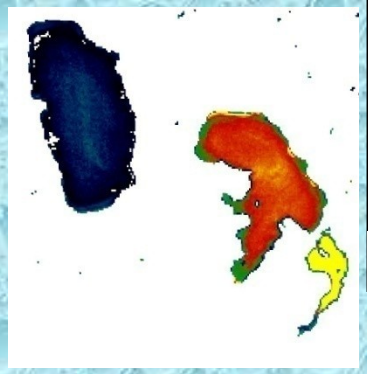





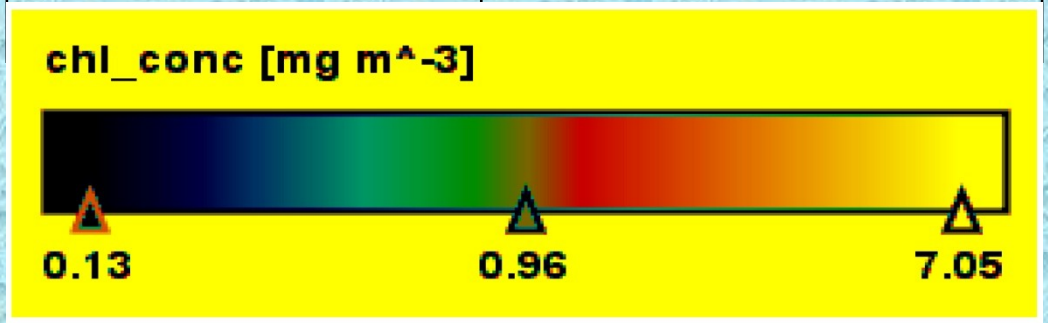
## Water quality: Total Suspended sediments

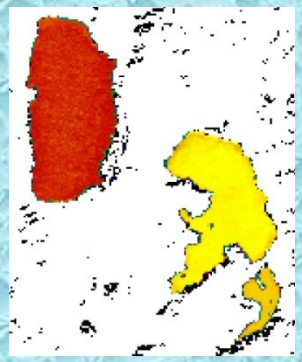
# Hydrology from Space: Monitor spatial & temporal changes of water quality…

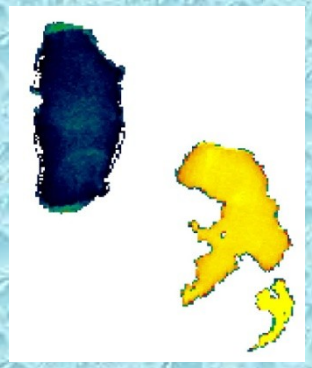




| | |
|---|---|
| **A** Chl_Conc [mg m^]$^{-3}$ 0.07 to 6.67: 21 / 8 / 2007 | **B** Chl_Conc [mg m^]$^{-3}$ 0.02 to 13.56 : 15 / 2 / 2008 |
| **C** Chl_Conc [mg m^]$^{-3}$ 0.21 to 11.03 : 1 / 5 / 2008 | **D** Chl_Conc [mg m^]$^{-3}$ 0.13 to 7.05: 15/8 /2008 |

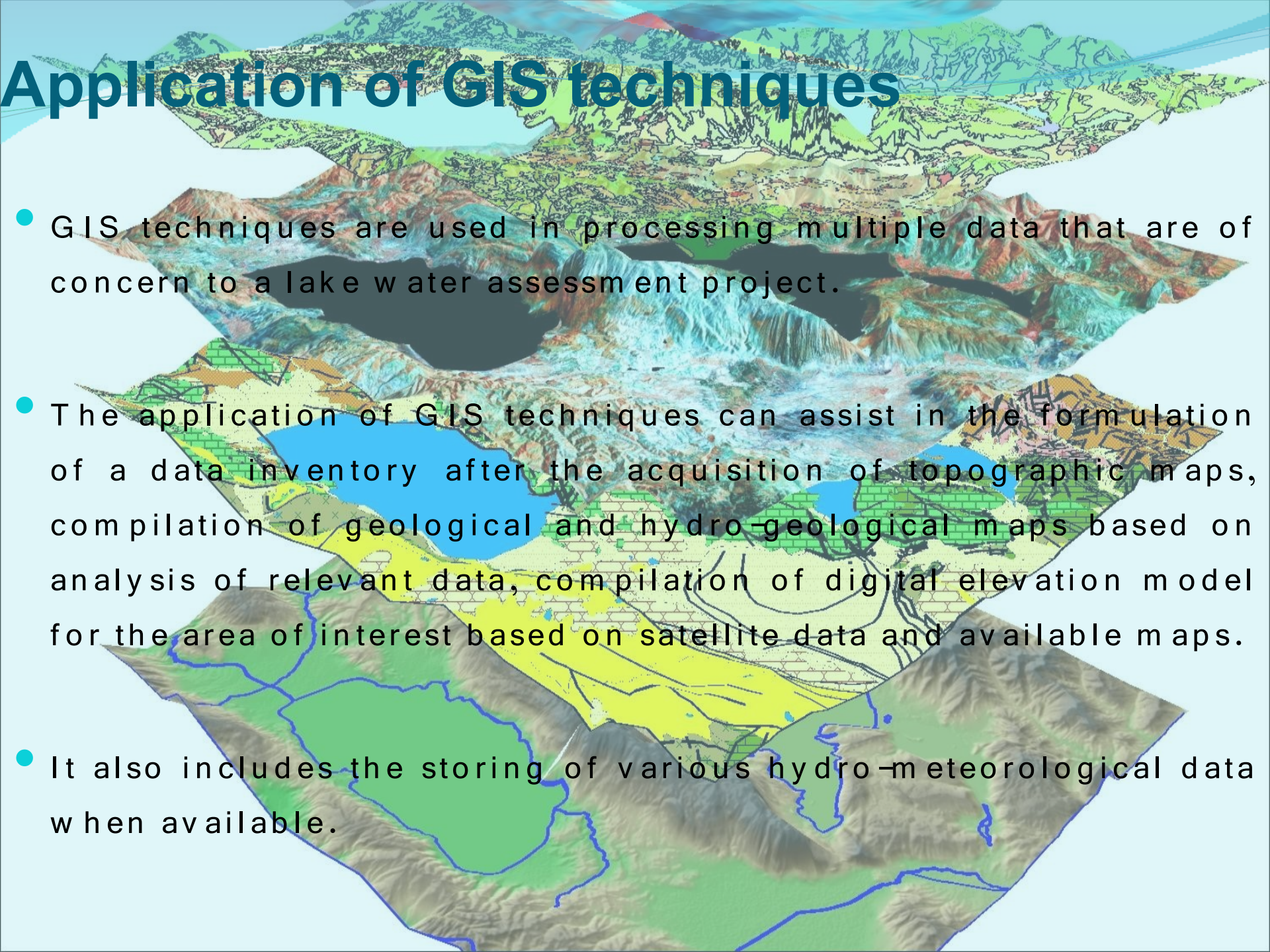




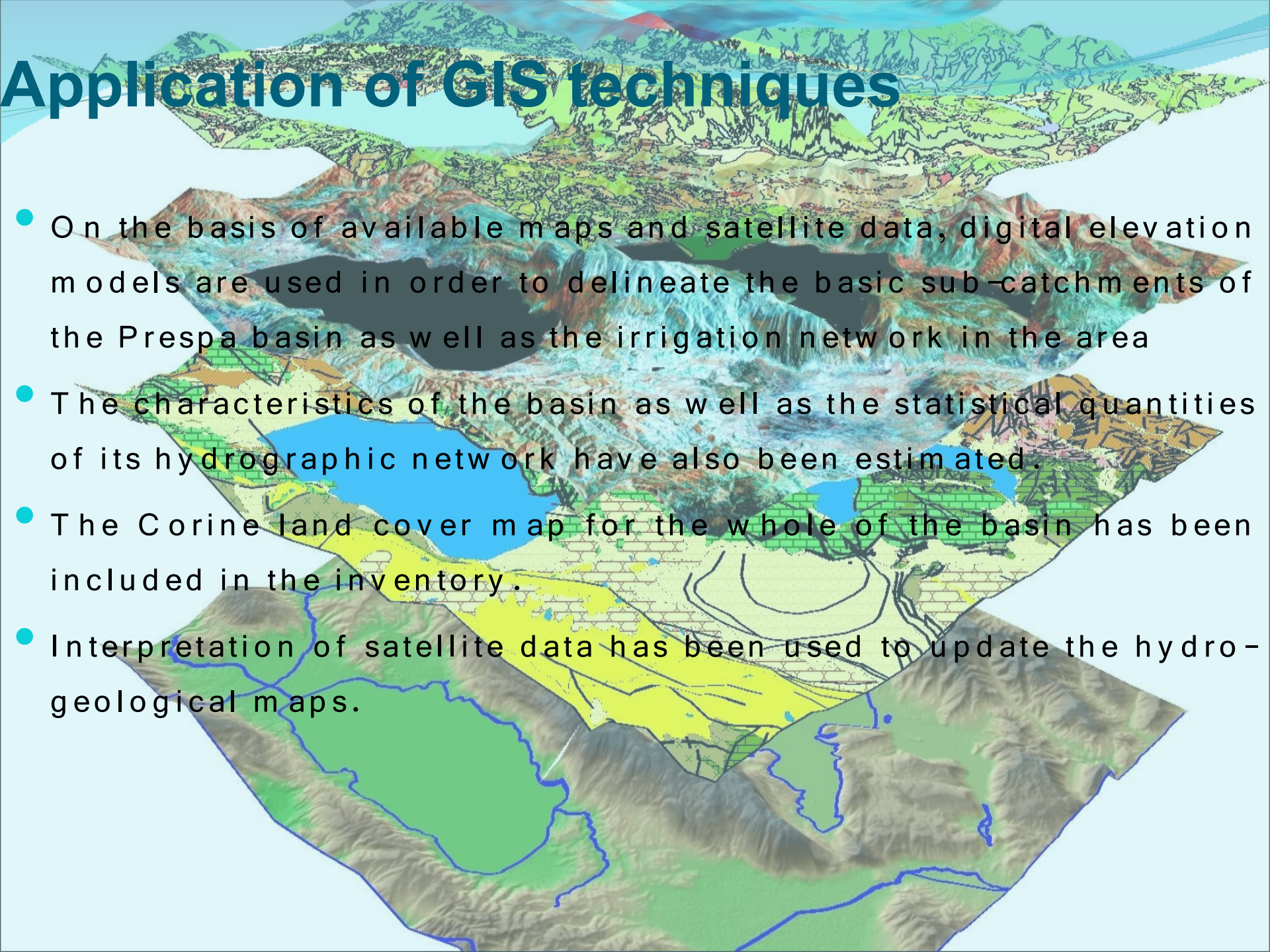
Water quality: Chlorophyl concentration

# Application of GIS techniques



- GIS techniques are used in processing multiple data that are of concern to a lake water assessment project.
- The application of GIS techniques can assist in the formulation of a data inventory after the acquisition of topographic maps, compilation of geological and hydro-geological maps based on analysis of relevant data, compilation of digital elevation model for the area of interest based on satellite data and available maps.
- It also includes the storing of various hydro-meteorological data when available.

# Application of GIS techniques



- On the basis of available maps and satellite data, digital elevation models are used in order to delineate the basic sub-catchments of the Prespa basin as well as the irrigation network in the area
- The characteristics of the basin as well as the statistical quantities of its hydrographic network have also been estimated.
- The Corine land cover map for the whole of the basin has been included in the inventory.
- Interpretation of satellite data has been used to update the hydro-geological maps.

# The Prespa /Ochrid pilot project region is situated in the Balkan Peninsula, in southeastern Europe, at the borders between Albania, Greece, and the FYR of Macedonia


**The entire Prespa basin has been declared a trans-boundary protected area, with the establishment of the "Prespa Park" by the Prime Ministers of Albania, Greece and the FYR of Macedonia on 2 February 2000**

**The three lakes constitute a common hydraulic system.**

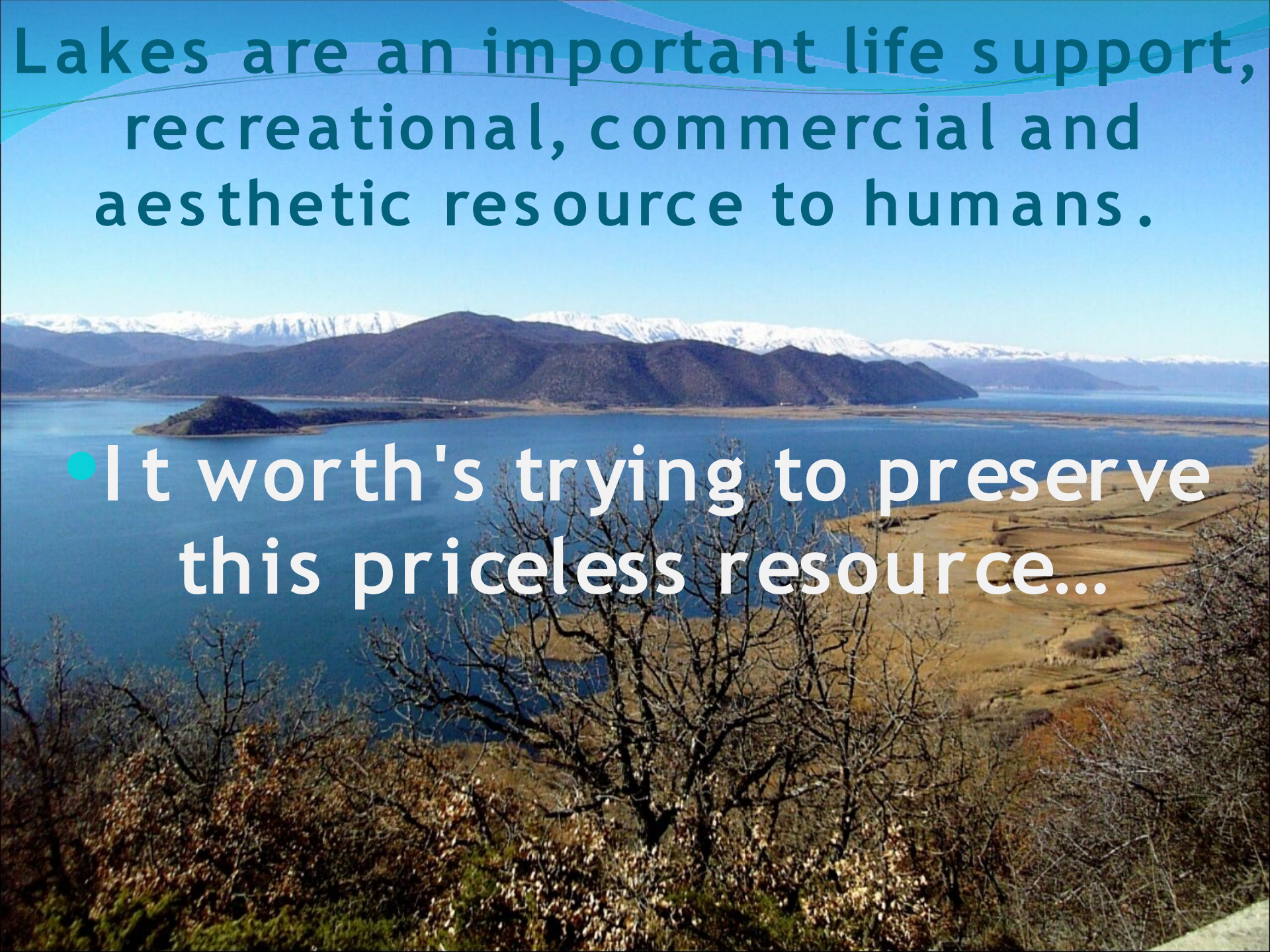
# Tools of analysis / Processing techniques

- Processing techniques that have been applied include integrated image processing /GIS vector data techniques.
- The BEAM software has been used to read and process the MERIS images and to export data into Geo-Tiff format.
- All data have been imported to TNTmips V 7.4 which supports fully integrated GIS, image processing, CAD, TIN, Desktop cartography and geospatial database management tools.
- Geometric and radiometric corrections were performed on the satellite images in order to prepare them for further processing and analysis.

# Macro – Micro Prespa and Ochrid lakes which have been used as pilot project area are:

# One of the most valuable lakes of Europe in terms of biodiversity

# Ochrid is the oldest lake in Europe and one of the oldest in the world.



# Lakes are an important life support, recreational, commercial and aesthetic resource to humans.

- It worth's trying to preserve this priceless resource…