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→ 4th ADVANCED TRAINING COURSE IN LAND REMOTE SENSING

EO Based fire disaster management services

Burnt Area Mapping

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INTRODUCTION

- Aim of this training is to present a methodology, developed by NOA, for mapping burned areas (burnt scar mapping)
- The area of interest is near Ebros, Greece, where a large fire event took place in 2011
- Software requirements:
  - ERDAS Imagine 2011 (Orthorectification and Main detection process)
  - ESRI ArcGIS >= 9.3.1 (Refinements, noise removal)
- Data input:
  - LandSAT5_2011_evros.tif
  - LandSAT5_2011_evros_mask.tif

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Session Planning

- An overview of the methodology will be presented
- The methodology will be fully explained, to understand the reasons behind each course of action
- when it is required, the required actions will be marked explicitly

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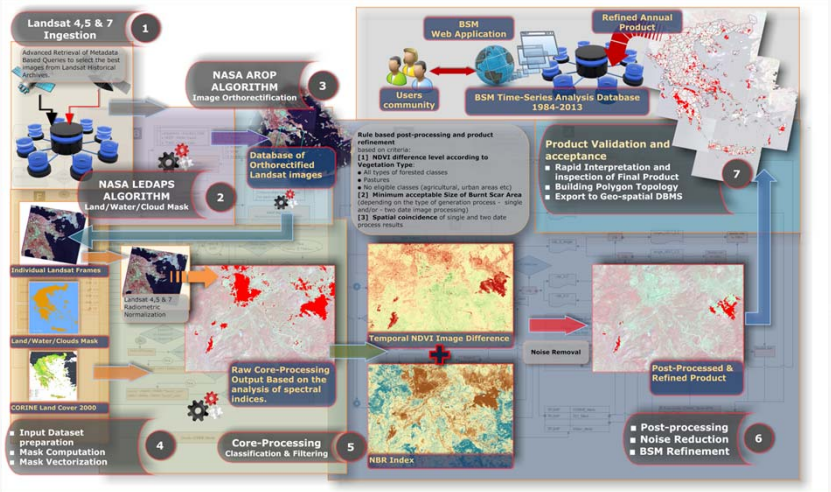
Methodology Overview



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STEP 1: Data Retrieval

- The methodology is based on LandSAT 4,5 and 7 imagery
- The data can be freely acquired from http://glovis.usgs.gov/
- To map historical fires, advanced queries are performed, based on the available metadata
- For the purposes of this training section, the data have already been retrieved (LandSAT5_2011_evros.tif, LandSAT5_2011_giannena.tif within the FireMapping/InputDataset/ path)

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STEP 2: Image Mask Generation

- NASA *LEDAPS* (Land Ecosystem Disturbance Adaptive Processing System) algorithm is applied to the original data, to generate three masks:
  - Land Mask (0)
  - Water Mask (1)
  - Clouds Mask (2)
- These masks have been converted to binary masks (1 where is land, other wise 0)
- Applied at a later stage as a means of noise removal

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STEP 3: Image Orthorectification

- The ERDAS Imagine software is used for the orthorectification process
- The input image (LANDSAT5_2011_evros.tif) and the reference image (BASE_182032_2001_Band_5.tif) is required
- The ERDAS Imagine software is used to perform the transformation

- Actions to perform:
    1. Open ERDAS Imagine software
    2. In the contents panel, right click on the 2D_View section and select "Open raster layer"
    3. Navigate to the FireMapping/InputDataset/ and open the LANDSAT5_2011_evros.tif.
    4. Click yes, if you are asked to create pyramid layers

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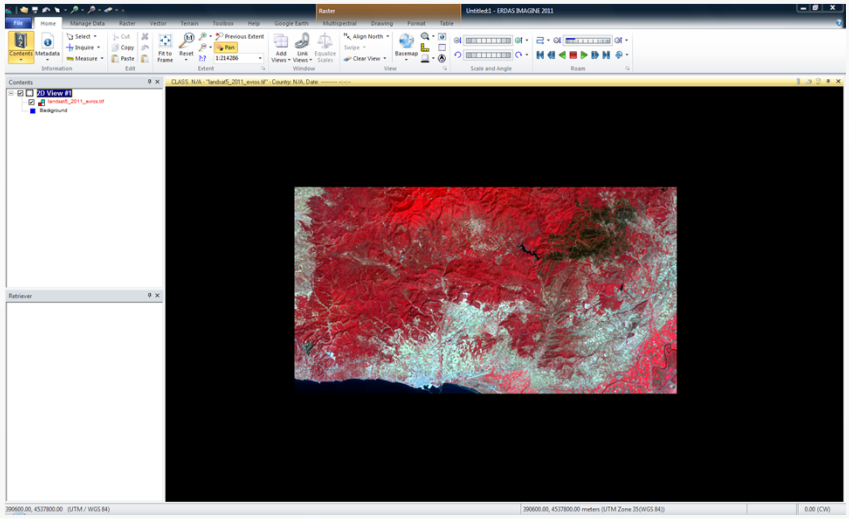
STEP 3: Image Orthorectification: Main window of ERDAS Imagine



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STEP 3: Image Orthorectification: ERDAS Imagine Panels

- Useful ribbons of the ERDAS Imagine:
  - *Raster:* Performs actions on a raster band, such as radiometric corrections, geometric calibration, image classification etc

  - *Multispectral*: It is available when a multispectral image is loaded. Enables the definition of color composites, histogram stretching etc.

  - *Panchromatic*: It is loaded when a panchromatic image is loaded. Performs similar operations to the *multispectral* ribbon

STEP 3: Image Orthorectification – Performing the process (1)

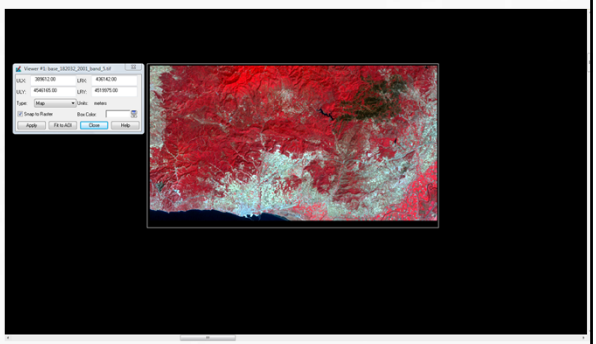
- Actions to perform:

1. From the *File* menu, the *New 2D view* is selected
2. The screen splits in two parts and in the *context* panel a new *2D View* section appears
3. The names of each view set are mentioned on the top part of the window
4. The base map is loaded in the second (right) screen of ERDAS by right clicking in the *2D View #2*, choosing *Open Raster Layer* and navigating to the FireMapping\Step3_Georeferencing\BaseMap directory and selecting the *BASE_182032_2001_Band_5.tif* file

STEP 3: Image Orthorectification – Performing the process (2)

- Actions to perform:

1. If the loaded image appears incorrectly, then on the *panchromatic* ribbon, left click on the *general contrast* (on the diagram) button
2. From the popped-up panel, on the *range adjust* select the *dynamic range adjust* and click *apply*
3. To make the images move simultaneously, from the *home* ribbon, select from the *linked views* drop down menu the *linked views* and *sync views* options
4. Create an Inquire box:
   - From the *Home* ribbon, click on the *inquire->inquire box*.
   - Resize the appeared wide box, to contain the whole image



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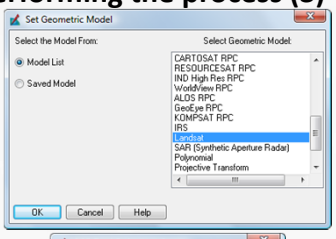
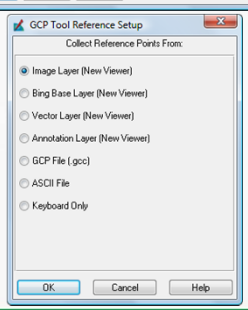
STEP 3: Image Orthorectification – Performing the process (3)

- Actions to perform:

1. From the *Multispectral* ribbon, select the *control points* button
2. In the menu appeared menu (Set Geometric Model), from the *Model List*, select the *Landsat* option and click OK
3. In the *GCP Tool Reference* window, select the *Image Layer* option
4. Navigate into the FireMapping\Step3_Georeferencing\BaseMap folder and load the BASE_182032_2001_Band_5.img file





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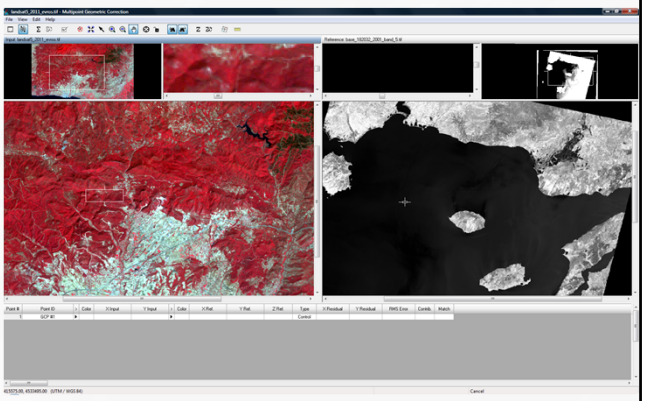
STEP 3: Image Orthorectification – Performing the process (4)

- Actions to perform:

1. In the *Landsat Model Properties* window add the gr_dtm_corine_rproj.tif as the elevation model file (FireMapping/InputDataset/).
2. Aim of the orthorectification process is to find the same points in the unrectified image (left) and the base image (right)
3. The points should be spread as much as possible
4. Proper points for the process, are points on artificial surfaces, like the edges of buildings, roads etc
5. A number of ~12 gcps should be sufficient for the orthorectification process



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STEP 3: Image Orthorectification – Performing the process (5)

- Actions to perform:

1. By using the tool *create gcp* a new gcp point can be added
2. The procedure is as follows:
   - Click on the *create gcp* button
   - Target a point on the left image
   - Click again the *create gcp* button
   - Target the same point on the right image
3. A least number of 5 points is required to compute the model
4. To solve the model, after entering the gcp points, press the *Solve geometric Model* button
5. If other points are entered on the base (or the reference image) after the model computation, the orthorectifier computes the position of the new point

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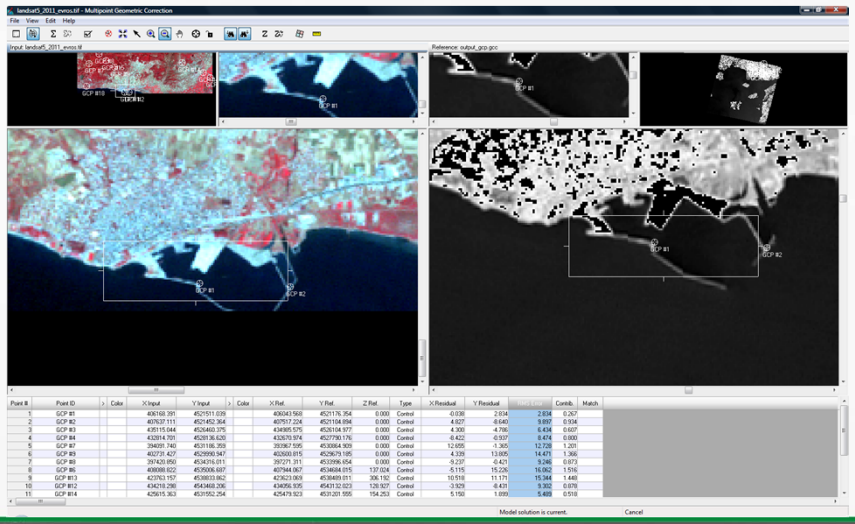
STEP 3: Image Orthorectification – Performing the process (6)



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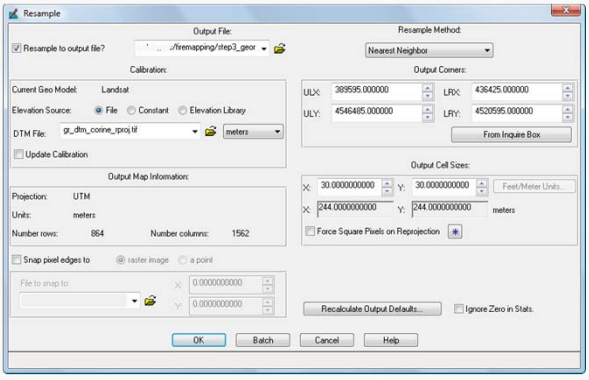
STEP 3: Image Orthorectification – Performing the process (7)

- Actions to perform:

1. To create the orthorectified image, left click on the *open image resampling dialog*
2. Set the path to FireMapping\Step3_Georeferencing and name the file user_Georeferenced_LANDSAT5_2011_evros.tif
3. The parameters should be similar to these on the left image
4. Press OK
5. Save the input (and reference) gcps from the *file->Save Input As* (and *Save Reference As*)
6. Perform the same process for the mask image (user_Georeferenced_LANDSAT5_2011_evros_mask.tif)



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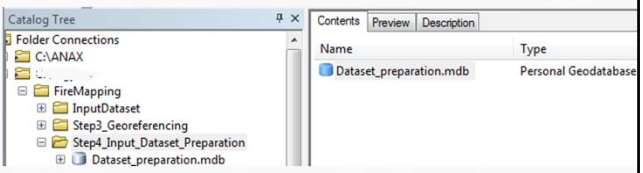
STEP 4: Input Dataset Preparation (1)

- The three masks (land, water, and cloud) are combined in one mask (already combined)
- Each mask is represented by a single value (0 – water, 1 – land, 2 – clouds)
- The final mask is vectorized within ArcGIS
- Actions to perform:

1. Open ArcCatalog
2. From the Catalog Tree, create a *Folder Connection* to the FireMapping Folder
3. Right click on the Step4_Input_Dataset_Preparation subfolder and from the *New* menu, select the *Personal Geodatabase* option
4. Name the database user_*dataset_preparation.mdb*



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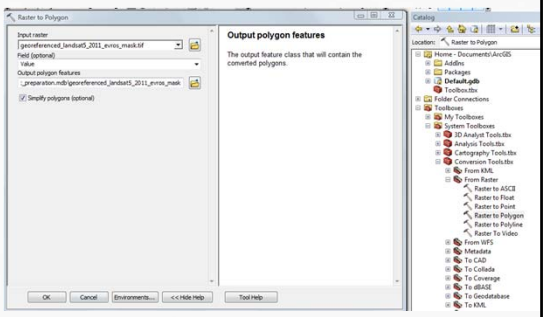
STEP 4: Input Dataset Preparation (2)

- Actions to perform:

1. Open ArcMap
2. From the *Add Data* button, open the user_georeferenced_landsat5_2011_evros_mask.tif image
3. From the Catalog toolbox, go to Toolboxes -> System Toolboxes -> From Raster -> Raster to Polygon
4. As input raster use the mask
5. For the output, navigate to the user_dataset_preparation geodatabase and save the polygons with the name *user*_georeferenced_landsat5_2011_evros_mask



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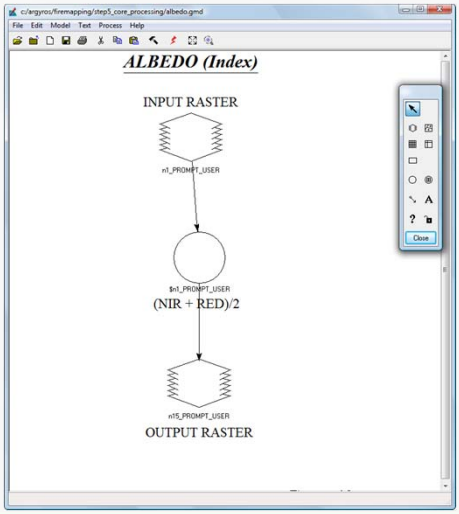
STEP 5: Core Processing – Classification and Filtering (1)

- To detect burnt areas on a first step, a series of indices needs to be computed
- These indices are the *Albedo* index and the NBR index
- Computation of Albedo Index:
- Actions to Perform:

1. From the *Toolbox* ribbon of ERDAS Imagine, open the *Model Maker* tool
2. Open the FireMapping/step5_core_processing/nbr_index.gmd
3. Press the *Execute Model* button
4. As input image set the *user*_georeferenced_landsat5_2011_evros.tif
5. As output image set the user_georeferenced_landsat5_2011_evros_albedo_index.tif



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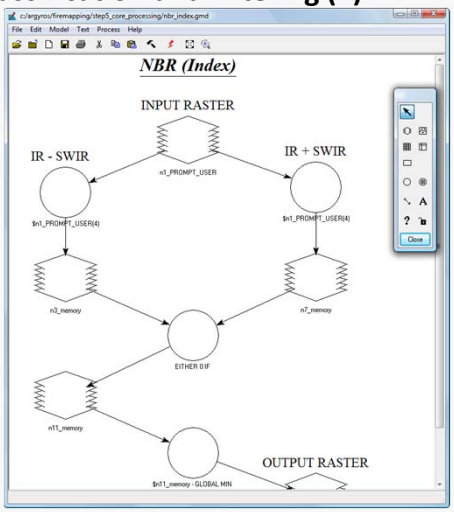
STEP 5: Core Processing – Classification and Filtering (2)

- Computation of NBR Index:
- Actions to perform:

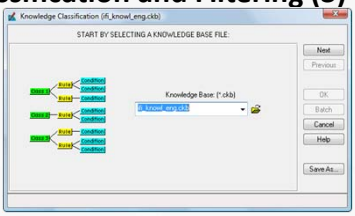
1. From the *Model Maker* open the Open the FireMapping/step5_core_processing/nbr_index.cmd
2. Press *Execute Model*
3. As input image set the user_georeferenced_landsat5_2011_evros.tif
4. As output image set the user_georeferenced_landsat5_2011_evros_nbr_index.tif

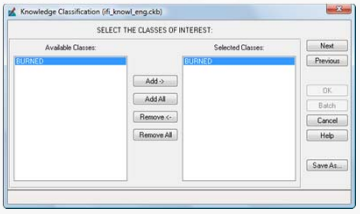


STEP 5: Core Processing – Classification and Filtering (3)

- An area is a possible burnt area, if all the following conditions are met:
  - NIR ≤ 60
  - NBR ≤ 126
  - Albedo ≤ 50
- ERDAS has a rule-based classification capability, enabling the user to classify image pixels based on heuristic rules, such as the above
- Actions to perform:

1. From the *Raster Ribbon,* From the *Knowledge Engineer,* open the *Expert Classifier*
2. Select the FireMapping\Step5_Core_Processing\ ifi_knowl_eng.ckb as knowledge base and press Next
3. Select the *Burned* class as the available class

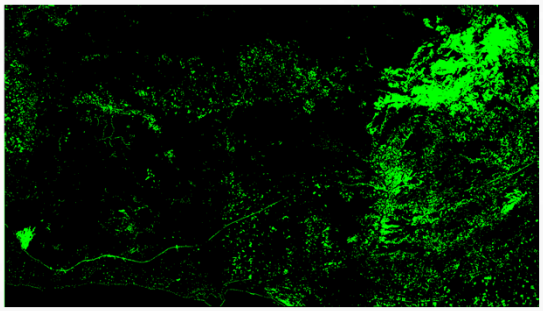




STEP 5: Core Processing – Classification and Filtering (4)

- Actions to perform:

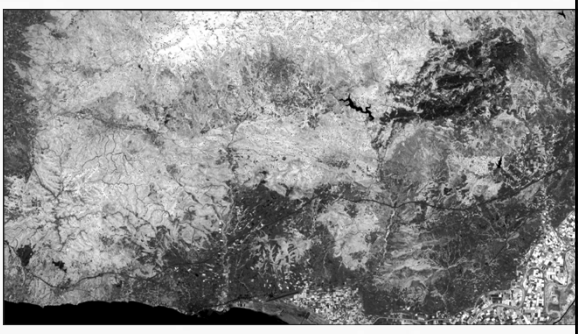
1. Set the *user*_georeferenced_landsat5_2011_evros.tif as the NIR image
2. Set the respective images files for the albedo and NBR indices and Press Next
3. In the *output classified image* field set the path FireMapping\Step5_Core_Processing and name the output image user_landsat5_2011_evros_knowledge_processing1.img



STEP 5: Core Processing – Classification and Filtering (5)

- Changes in present vegetation, under certain conditions, could imply fire position
- A common vegetation index, is the NDVI (Normalized Difference Vegetation Index)
- NDVI is computed as (NIR-RED)/(NIR+RED)
- In ERDAS, NDVI can be computed from the *raster* ribbon -> Unsupervised -> NDVI
- Actions to perform:

1. Open the NDVI computation window
2. Set as input file the user_georeferenced_landsat5_2011_evros.tif
3. Set as output file the user_georeferenced_landsat5_2011_evros_ndvi_index.tif
4. 4. Perform the same process for the landsat_2010_evros.tif (FireMapping\Step5_Core_Processing\additional data)



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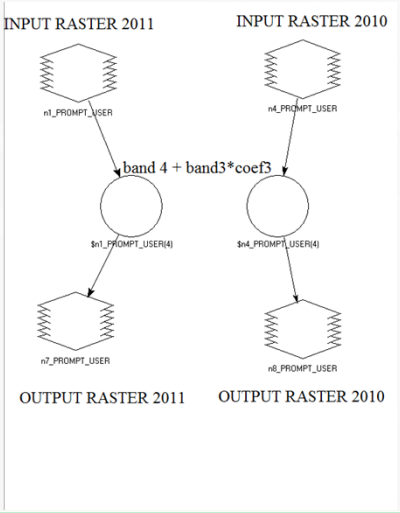
STEP 5: Core Processing – Classification and Filtering (6)

- Computation of BaseSum43 and RefSum43 indices
- These indices are computed as follows:
  Base4+base3*base3_coef
  Ref4+ref3*ref3_coef
- Actions to perform:

1. In the *model maker* window load the basesum_refsum.gmd model
2. As input image on the left, set the user_georeferenced_landsat5_2011_eSTEP 5: Core Processing – Classification and Filtering (6) vros.tif
3. As input image on the right, set the user_landsat_2010_evros.tif
4. As output image on the left, set the user_georeferenced_landsat5_2011_evros_basesum43.tif
5. As output image on the right, set the user_landsat5_2010_evros_refsum43.tif



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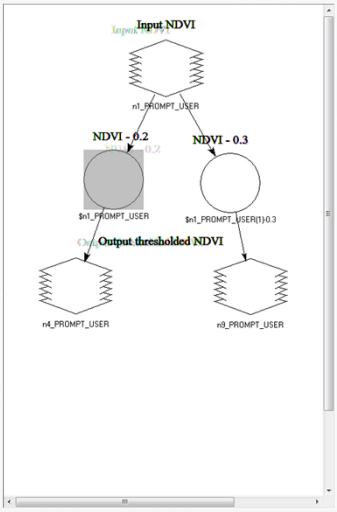
STEP 5: Core Processing – Classification and Filtering (7)

- Computation of NDVI thresholds
- Actions to perform:
- In the *model maker* window load the *ndvi_threshold_index.cmd*
- Set as input the NDVI of the 2011 image (user_georeferenced_landsat5_2011_evros_ndvi_index.tif)
- As output for the 0.2 threshold set the user_georeferenced_landsat5_2011_evros_ndvi_02_threshold.tif image
- As ouput for the 0.3 threshold set the user_georeferenced_landsat5_2011_evros_ndvi_03_threshold.tif
- Both should be saved in the FireMapping\Step5_Core_Processing directory



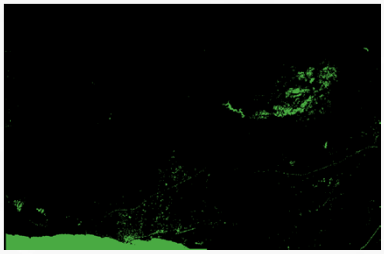
STEP 5: Core Processing – Classification and Filtering (8)

- An area is a possible burnt area, if all the following conditions are met:
  - BaseSum43 != 0
  - RefSum43 != 0
  - NDVIbase – thres <= - thres
- This action is performed for thres= 0.3 and thres = 0.2
- Based on this *rule*, a classification should be performed on the image
- Actions to perform:
- From the *raster* ribbon of ERDAS Imagine, open the *Knowledge classifier*
- Load the ndvi_knowl_03_eng.ckb

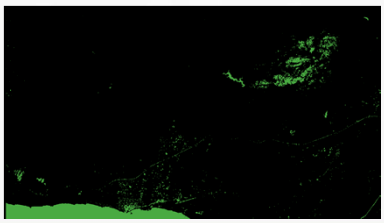
STEP 5: Core Processing – Classification and Filtering (9)

- Actions to perform:
- Set the corresponding raster files and press next
- On the next window, set the filename of the result as user_landsat5_2011_evros_ndvi_knowledge_processing_03.img
- The result should be equivalent to the image on the right
- Perform the same action with the ndvi_knowl_02_eng.ckb (user_landsat5_2011_evros_ndvi_knowledge_processing_02.img)

Threshold = 0.3



Threshold = 0.2



STEP 5: Core Processing – Classification and Filtering (10)

- The three fire results
  - user_landsat5_2011_evros_knowledge_processing1.img
  - user_landsat5_2011_evros_ndvi_knowledge_processing_02.img
  - user_landsat5_2011_evros_ndvi_knowledge_processing_03.img
- Have to be vectorized for the following refinement process
- For each of these rasters:
- Actions to perform:
  - Open ArcMap
  - From the ArcCatalog tab, locate the *Raster to Polygon*, under system toolboxes-> conversion tools -> from raster
  - Use the same names as the rasters without the file type extension
  - Make sure that the *Simplify polygons* is not selected
  - Save each vector in the FireMapping\Step6_post_processing\step6_geodatabase.gdb\ geodatabase

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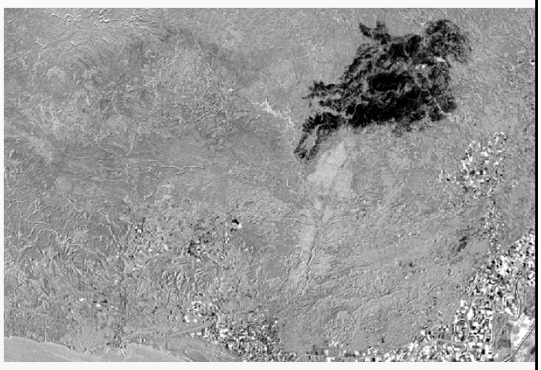
STEP 5: Core Processing – Classification and Filtering (11)

- Differences in vegetation can be detected, by computing changes of the NDVI index of two seasons.
- Computation of NDVI Difference by substraction of the NDVI reference (2010) from the NDVI base (2011)
- Actions to perform:
- From the *raster ribbon* of ERDAS Imagine, from the functions menu, open the *two image functions.*
- As input image on the left side, set the user_georeferenced_landsat5_2011_evros_ndvi_index.tif
- As input image on the right side, set the user_landsat5_2010_evros_ndvi_index.tif
- As output image, set the user_landsat5_2011_evros_ndvidiff.tif
- As operation, between the bands, select the substraction



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STEP 6: Post Processing – refinements (1)

- Detected areas, contains different kinds of noise
  - water areas were detected as burnt areas
  - Salt and pepper noice
  - False alarms
- Post processing step, contains a variety of refinement steps, aiming to clear false alarms, salt and pepper noise etc.
- As natural grasslands produces many false alarms, due to changes to present vegetation, which is caused by pasture, these areas should be removed.
- A raster mask is generated, based on the NDVI diff and the NDVIref (2010) which is on a later step vectorized and refined with the Corine Land Cover (CLC), within the ArcGIS environment

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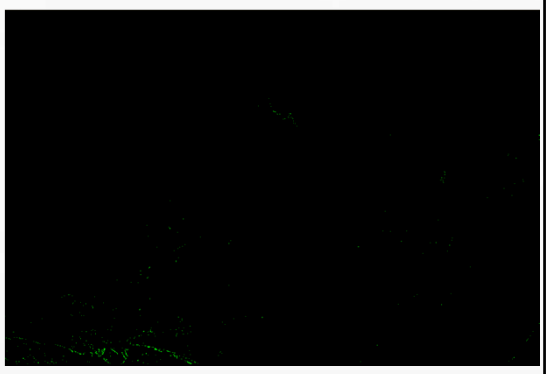
STEP 6: Post Processing – refinements (2)

- Actions to perform:
- From the *raster ribbon* of ERDAS Imagine, open the *Knowledge classifier*
- Navigate to FireMapping/Step6_post_processing and load the ndvi_diff_mask.ckb
- On the classes dialog, set the *positive mask* as active
- Set the paths to the respective images
- Set the output image as user_landsat_2011_evros_ndvi_diff_mask.img and save it in the Step6_post_processing folder



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STEP 6: Post Processing – refinements (3)

- Actions to perform:
- Open ArcGIS 10.0
- From the *Catalog* tab on the right, create a connection to the FireMapping Folder
- Navigate to the FireMapping/step6_postprocessing directory
- From the NOA toolbox, load (right click -> edit) the fire_diff_mask.tbx
- Correct the paths of the respective files
- Save the mask as user_landsat_2011_evros_natural_grassland_mask inside the step6_geodatabase.gdb

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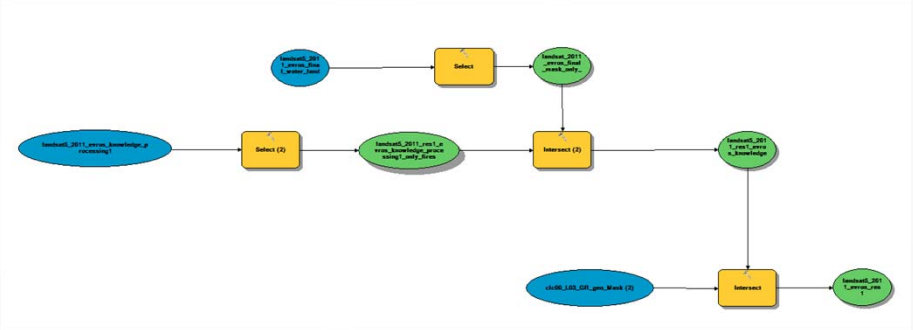
STEP 6: Post Processing – refinements (4)

- Generation of final mask.
- The final mask is computed with the following formula:
  mask_base +mask_base*mask_ref
- This mask should be later vectorized, to perform certain masking
- Notice that the georeferenced mask layers should be used
- Actions to perform:

1. From the ArcToolBox, open the *Raster Calculator* Tool, under System Tools-> Spatial Analyst Tools -> Map Algebra
2. Set the following formula:
3. "LandSAT5_2011_evros_mask" + ("LandSAT5_2011_evros_mask" * "landsat_2010_evros_mask ")
4. Set the output file name as user_landsat5_2011_evros_final_water_land_cloud_mask.tif
5. The mask is later vectorized in the same way as the previous rasters

STEP 6: Post Processing – refinements (5)

- The remaining refinement process has been split in 5 parts, within the ArcGIS environment
- The first step aims to extract the fires that were detected due to data from the base image



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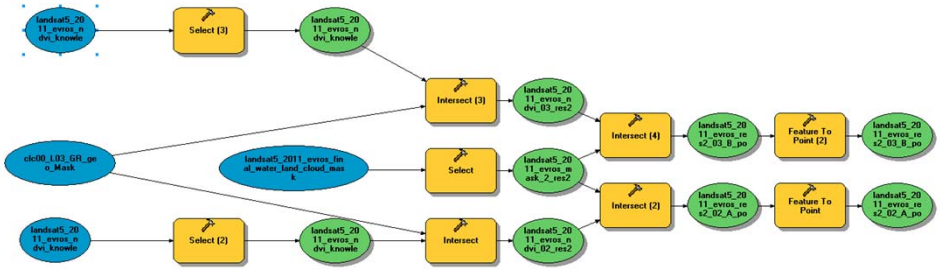
STEP 6: Post Processing – refinements (6)

- The second step, extracts the centroids, of the fires, that where detected with the 0.2 and 0.3 NDVI thresholds from areas that had similar spectral profile in the base and the reference image



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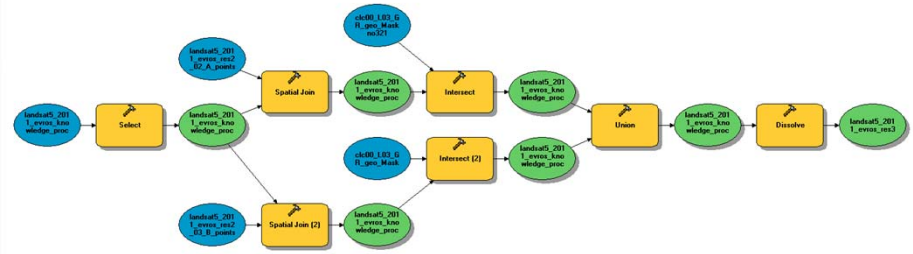
STEP 6: Post Processing – refinements (7)

- In the third step, the centroids from the second step, are spatially joined with the burnt areas detected (100m buffer) from the initial process and extracts the respected polygons.
  - If the polygons were detected by the 0.2 NDVI threshold, then they are clipped with a natural vegetation mask
  - If the polygons were detected by the 0.3 NDVI threshold, then they are clipped with a natural grasslands mask
  - In the end all adjacent polygons are merged



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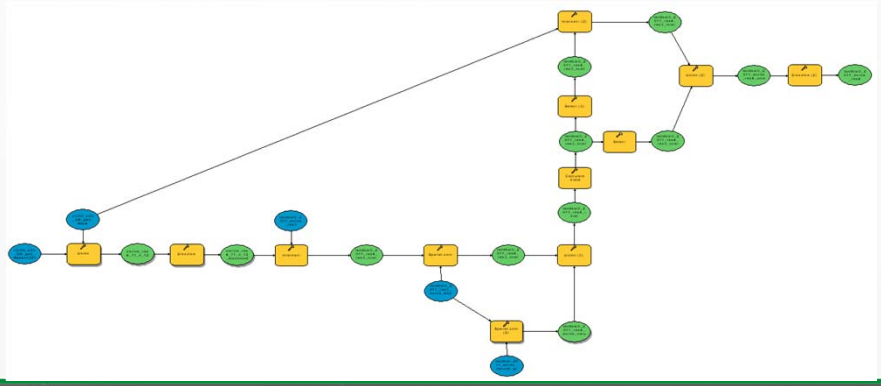
STEP 6: Post Processing – refinements (8)

- In the fourth refinement step, it is checked the area percentage of the burnt areas, detected from the first process, with the areas extracted from the third refinement step
- If it is smaller than 80%, then the polygon remain as is, otherwise it is clipped with a mask, based on Corine Land Cover, containing the natural vegetation and grassland areas



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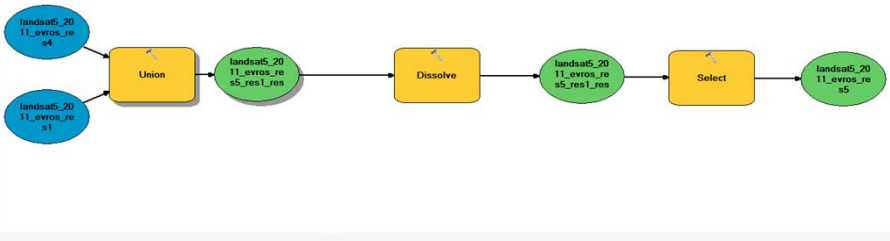
STEP 6: Post Processing – refinements (9)

- The final burnt areas are consisted by the polygons, detected on the first and fourth refinement step, with area greater than 50000 m^2



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STEP 6: Post Processing – refinements (10)

- Actions to perform:
- From the NOA.tbx, open each refinement step, by right clicking each process and clicking *edit*
- Check the properties and settings of each sub-process
- Set the proper path for each file, and rename the output of each file (prefix the output names with the *user_* prefix)
- Compare your result with the result given to you

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Τοπικά Νέα › Αν. Μακεδονία & Θράκη ›

Έβρος: Στάχτη πάνω από 47.000 στρέμματα

ΤΟΠΙΚΑ ΝΕΑ Παρασκευή, 26 Αυγούστου 2011 16:24

Εκτύπωση Αποστολή Φυλάξτε το Μέγεθος Ακούστε το

Παρανάλωμα έχουν γίνει πάνω από 47.000 στρέμματα στο νότιο τμήμα του Έβρου, από τη μεγάλη πυρκαγιά που συνεχίζει ανεξέλεγκτη από το μεσημέρι της Τετάρτης το καταστροφικό της έργο.

Η περιοχή έχει κηρυχθεί σε κατάσταση εκτάκτου ανάγκης ήδη από την Πέμπτη, ενώ έχει ζητηθεί και διεθνής συνδρομή εναέρων πυροσβεστικών μέσων.

Τα πύρινα μέτωπα εντοπίζονται στα σημεία Μελία, Κοίλα, Ύψωμα 22 και Κιτρινόπετρα, ενώ οι περιοχές Σουφλίου, Αλεξανδρούπολης και Σαμοθράκης έχουν σήμερα δείκτη υψηλής επικινδυνότητας 4.

Στο έργο της κατάσβεσης παίρνουν μέρος 175 πυροσβέστες με 47 οχήματα από ολόκληρη τη βόρεια Ελλάδα, ενώ από αέρος επιχειρούν τέσσερα καναντέρ και άλλα τέσσερα ελικόπτερα. Τις επόμενες ώρες αναμένεται να συνδράμουν τις δυνάμεις της Πυροσβεστικής ακόμη τέσσερα αεροπλάνα καναντέρ, από τη Γαλλία και την Ισπανία.

Στα μέτωπα των πυρκαγιών έχει σπεύσει και μεγάλος αριθμός μηχανημάτων της περιφέρειας, του στρατού, δήμων και του δασαρχείου.

Μέχρι στιγμής δεν απειλούνται κατοικημένες περιοχές, ενώ για προληπτικούς λόγους εκκενώθηκε το χωριό Κοίλα και μια μονάδα της αεροπορίας. Επίσης ειδοποιήθηκαν οι κτηνοτρόφοι της περιοχής, για την απομάκρυνση των ζώων από τις μονάδες τους.

Στην αστυνομία κρατείται εν τω μεταξύ ένας 48χρονος αγρότης, με την κατηγορία του εμπρησμού από αμέλεια.

Πηγή: ΑΠΕ-ΜΠΕ

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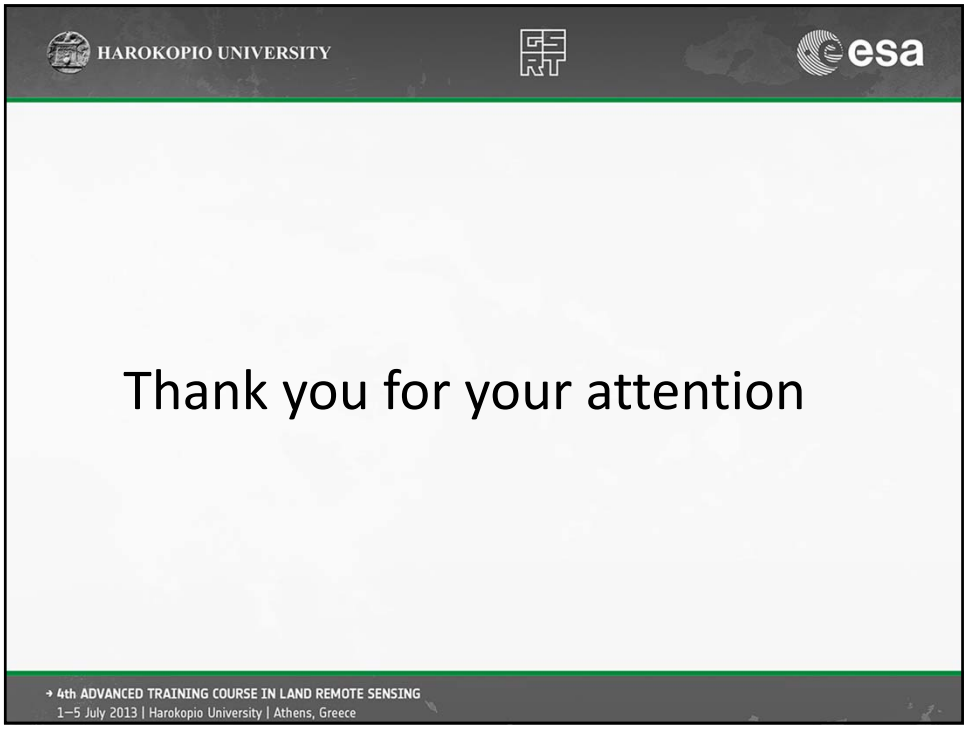
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Thank you for your attention
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