XXIV FIG International Congress 2010
Facing the Challenges - Building the Capacity
Sydney Convention & Exhibition Centre
11-16 April 2010
Sydney, Australia

Identification of Crop Areas Using SPOT – 5 Data

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TS 3H – Remote Sensing and Imagery I

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Center For Satellite Communications & Remote Sensing

ITU-CSCRS
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ITU-CSCRS

Istanbul Technical University - Center for Satellite Communications and Remote Sensing

was established in 1996 as a research and technology project that firstly named

ITU-SAGRES

SAtellite Ground REceiving Station)

State Planning Organization funded the project

an investment of 20 million$.

The station became operational in 2000 and reconstituted as

ITU-CSCRS

in May 2003.

ITU-CSCRS is one of the forecoming institutions around the world with a highly capable ground receiving station unit and is the first ground receiving station Turkey.

Istanbul Technical University
Center For Satellite Communications & Remote Sensing

Mission

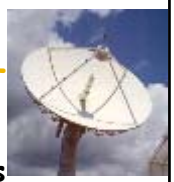
➢To develop an advanced capability in remote sensing and satellite communications to meet the scientific and operational requirements of Turkey.

Vision

➢To be a leading center for organization and execution of

- ➢ the civil/military applications,
- ➢ the national/international projects,
- ➢ education/training programs related to remote sensing and satellite communications.

Satellite Communication

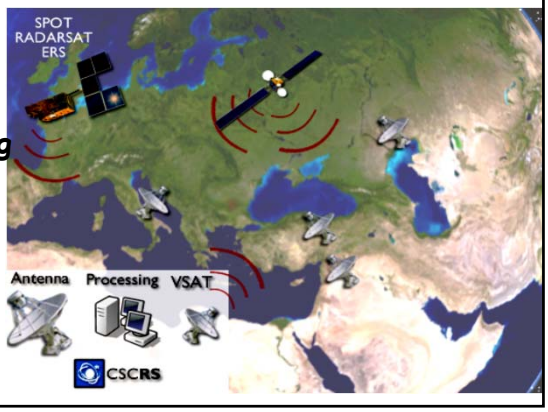


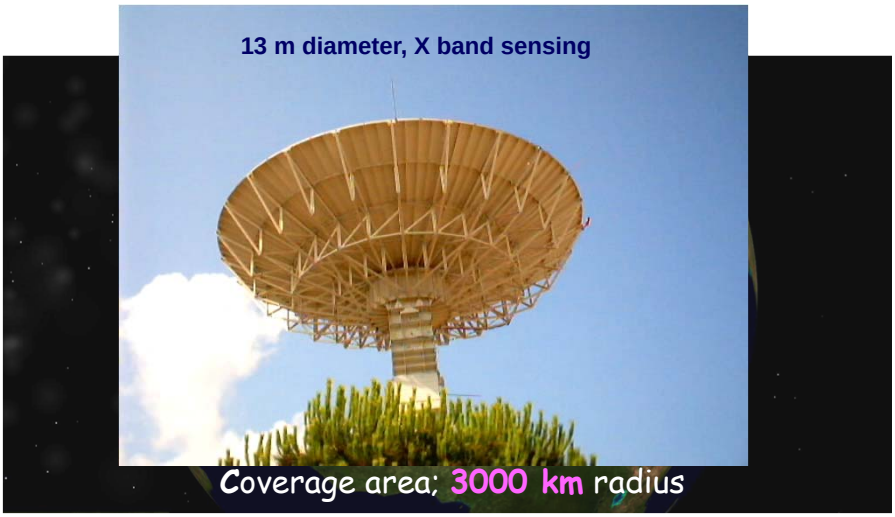
➢**2.4m and 4.6m diameter VSAT antennas,**

➢**data acquisition from the satellites with Ku – Band wawelentgh**

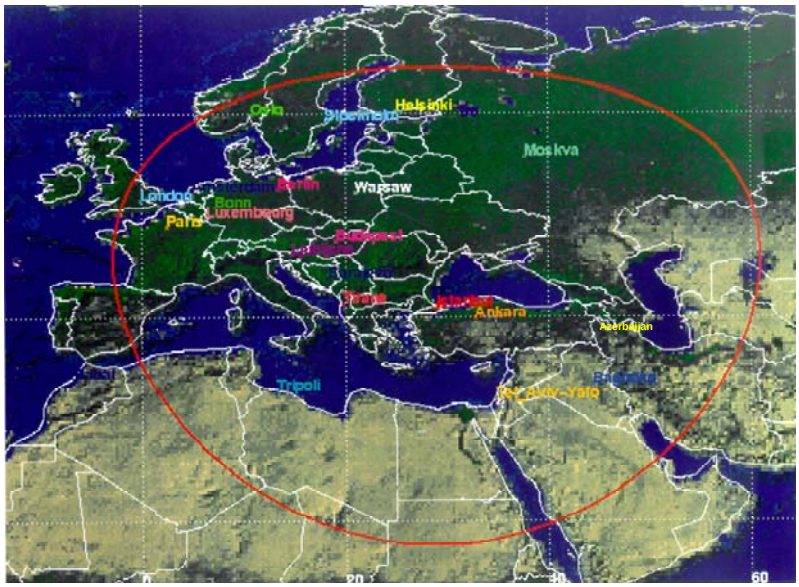
Application Fields

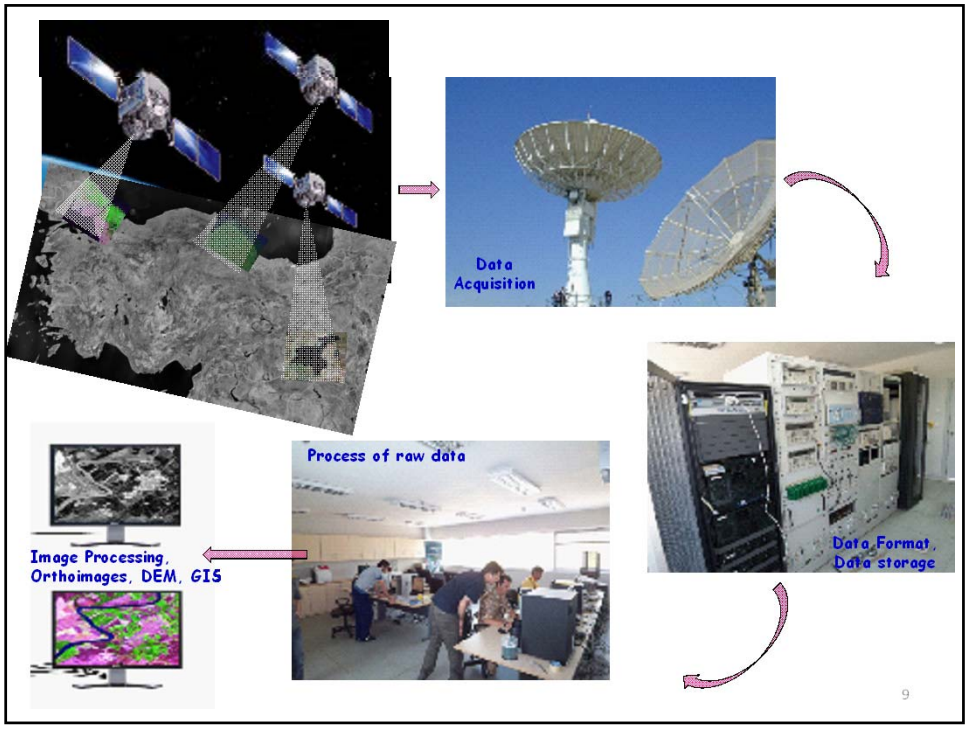
- **Wireless Internet**
- **Distance education/learning Applications**

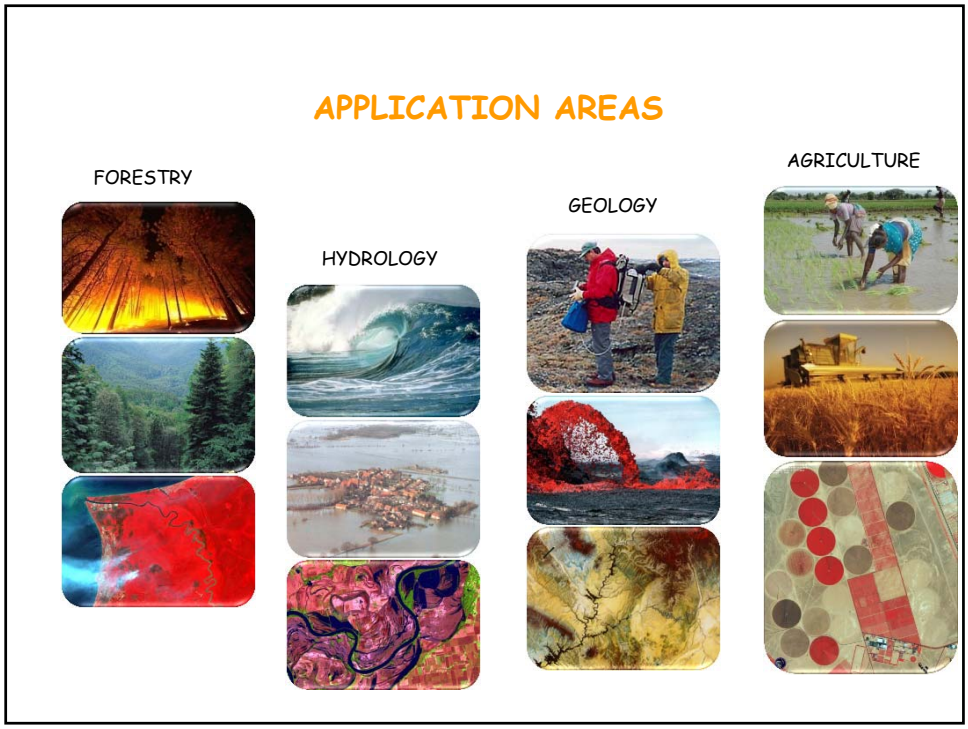


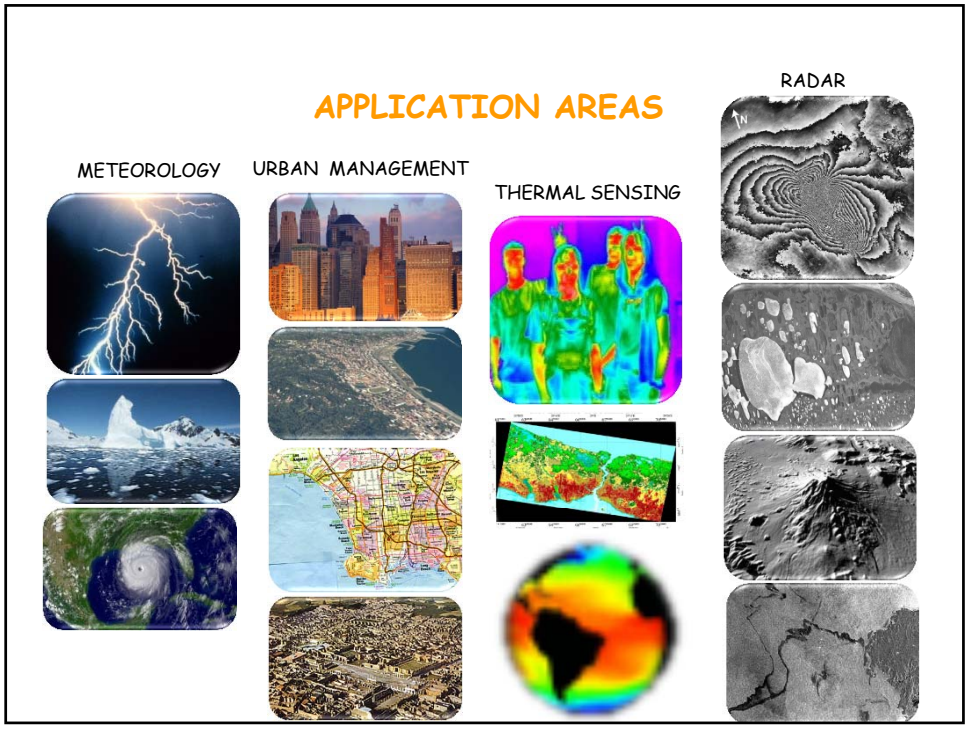


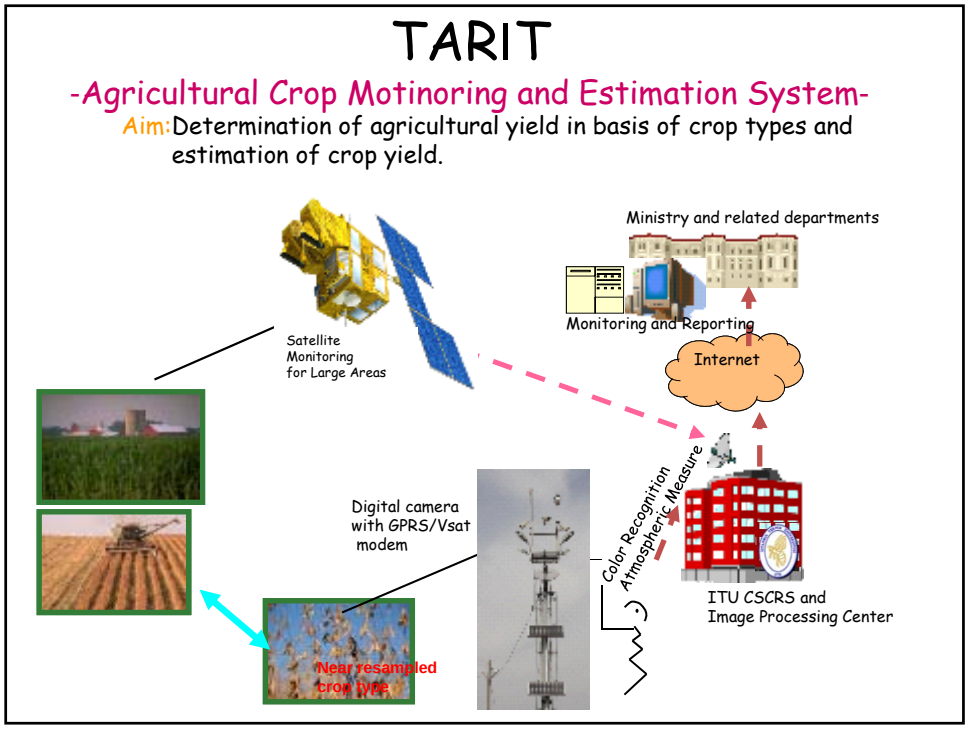
- SPOT 2 /4, SPOT 5
- RADARSAT-1 / ERS-2

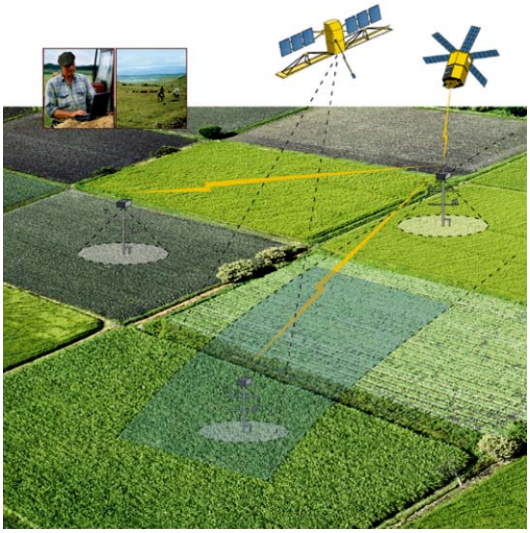



Data Acquisition
Data Format, Data storage
Process of raw data
Image Processing, Orthoimages, DEM, GIS
9


APPLICATION AREAS
FORESTRY
HYDROLOGY
GEOLOGY
AGRICULTURE


APPLICATION AREAS
METEOROLOGY
URBAN MANAGEMENT
THERMAL SENSING
RADAR


TARIT
-Agricultural Crop Motinoring and Estimation System-
Aim: Determination of agricultural yield in basis of crop types and estimation of crop yield.
Ministry and related departments
Monitoring and Reporting
Internet
Satellite Monitoring for Large Areas
Digital camera with GPRS/Vsat modem
Color Recognition
Atmospheric Measure
ITU CSCRS and Image Processing Center
Near resampled crop type



✓Estimation of current Agricultural Yield

✓Synchronous reporting in basis of time and crop type

✓Damage and crop loss reporting after disaster

✓Early warning for the disease growth due to climatic effects and agriculturaldisease

✓Report based desicion support system for agricltural management

Background

- Remote sensing applications to agriculture: crop type and area determination using different classification methods.
- Crop productivity information (crop type and spatial coverage of that crop) is very important for accurate crop yield estimation
- Crop productivity can be expressed in terms of
  - vegetation health
  - biomass density

  } From spectral reflectance differences in different bands
- Spatial coverage of the crop area } By shape and specific texture from satellite imagery.
- Remotely sensed data and analysis can be used to create crop maps.
- Other studies show that determination of different crop types in their growing stages cannot be performed efficiently with single dated images. Classification of multitemporal images gives identifiable results with added phenologic information

Methodology

- We used pixel-based and object-based classification methods to
  - identify the boundaries of agricultural fields,
  - determine the areal distribution of the crops from multitemporal imagery.
- Accuracy and efficiency of the pixel based and object based classification techniques were compared within different spectral and spatial aspects; using kappa statistics and confusion matrix.

STUDY AREA

- Sanliurfa , population ~ 465,000.
- South-eastern region of Turkey
- Important province within the Southeastern Anatolia Project (GAP) which is one of the most crucial projects of Turkish Government.
- GAP project aims to improve productivity and diversify agricultural activities.
- SanliUrfa has the highest proportion of agricultural production of Turkey:
  - 35% of cotton production,
  - 8% of wheat production and
  - 55% of the peanut production.
- Huge agricultural fields such as Ceylanpinar, Akcakale and Koruklu are located in SanliUrfa and these fields are under the control and management of the Ministry of Agriculture entities.

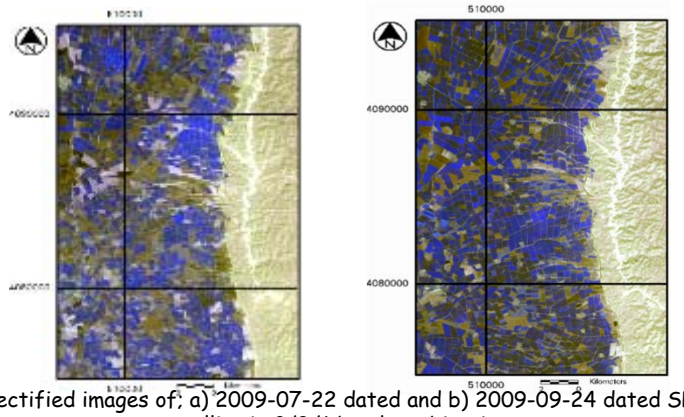
Study Area

- The study area: East Harran
- Located in the east of Akcakale region,
- Large agriculture parcels and controlled agricultural activity.
- Between the seventh and ninth month of the year, only cotton and corn were farmed in this region.
- The planting and harvesting of the parcels are not stable, so different stages of farming can be seen on the satellite imagery.

Study Area

Preprocessing

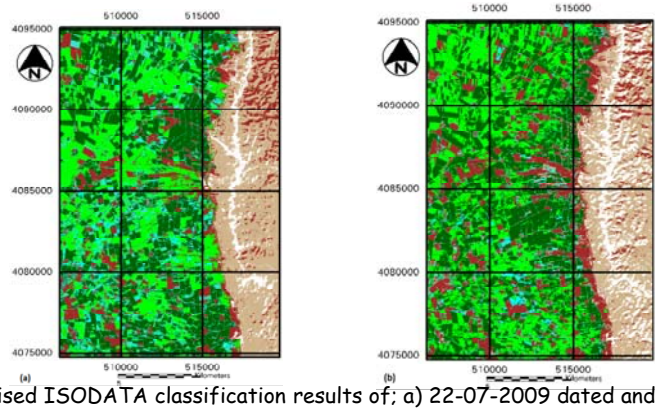
- 22-07-2009 and 24-09-2009 dated SPOT 5, multispectral images (four bands: B1: Green, B2: Red, B3: Near Infrared, B4: Middle Infrared) from High Resolution Geometric (HRG) sensors of the SPOT 5 satellite and have 10 meter spatial resolution.
- Orthorectification procedure to correct geometric distortions.
- In this procedure 30 m ASTER Global Digital GDEM digital elevation model (DEM) and ground control points (GCP) collected from 1/25000 scaled maps were used.
- Orthorectification procedures were resulted with ± 0, 30 and 0, 42 pixel root mean square error (RMSE), respectively.



Orthorectified images of; a) 2009-07-22 dated and b) 2009-09-24 dated SPOT 5 satellite in 2/3/1 band combination

Unsupervised Classification

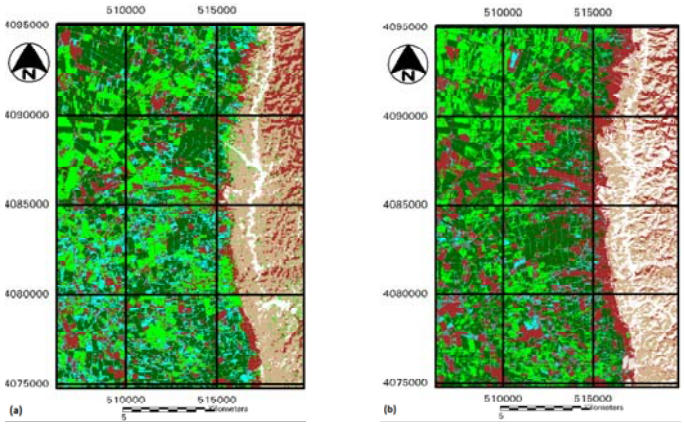
- Iterative Self-Organizing Data Analysis Technique (**ISODATA**) was used for unsupervised classification process. **1st**, **2nd** and **3th bands** of SPOT 5 images corresponding to near infrared, red and green wavelength portions were used for this classification. 20 spectral classes were created with 0, 99 convergence threshold. The results were interpreted visually and combined into 6 final classes with recode operation using ground truth information obtained from SanliUrfa Agricultural Research Institute.



Unsupervised ISODATA classification results of; a) 22-07-2009 dated and b) 24-09-2009 dated SPOT 5 satellite images (Dark Green: Cotton; Green: Corn; Magenta: straw; Brown: empty parcels, tan: Bare soil, white: dry river channels).

Supervised Classification

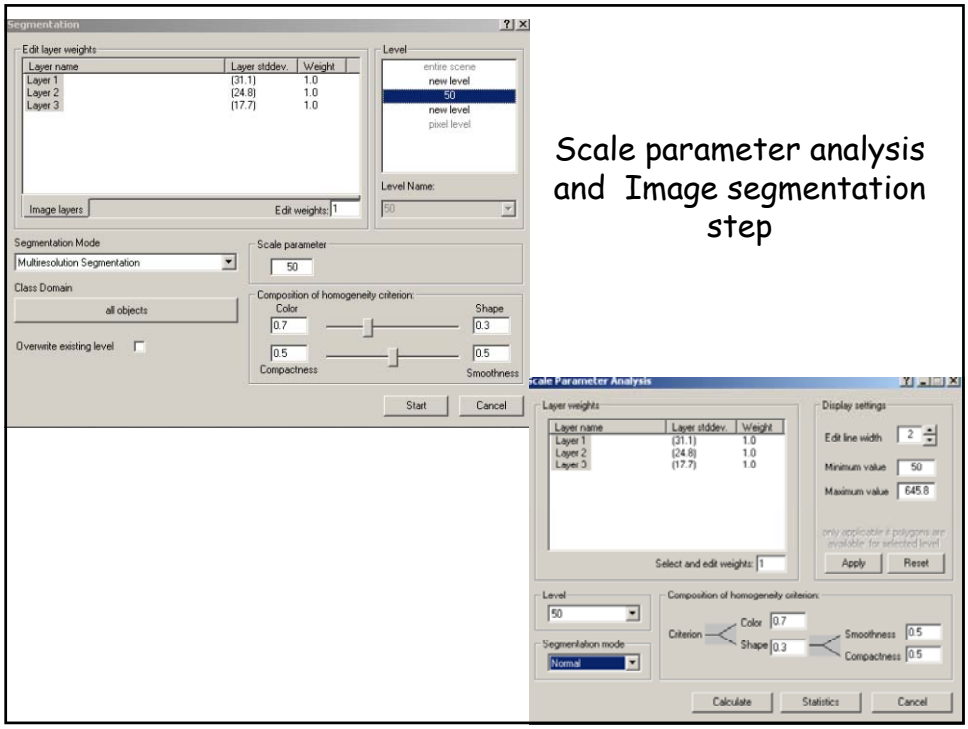
- In this study, **Maximum Likelihood** classification method was used for supervised classification. **40 training sites** with known ground truth were used as signatures. The classification of final 6 thematic classes are evaluated in first step with visual interpretation than digitally.



Maximum Likelihood supervised classification results of; a) 22-07-2009 dated and b) 24-09-2009 dated SPOT 5 satellite images (Dark Green: Cotton; Green: Corn; Magenta: straw; Brown: empty parcels, tan: Bare soil, white: dry river channels).

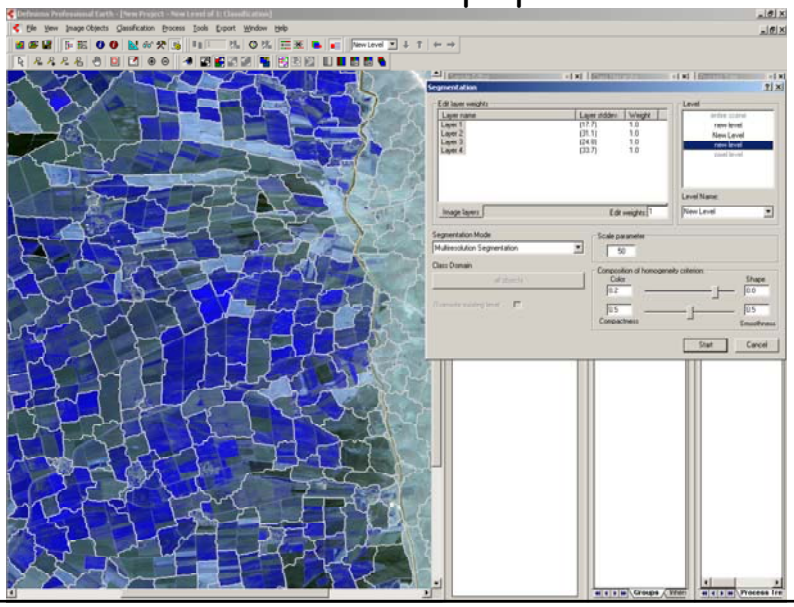
Object – Based Classification

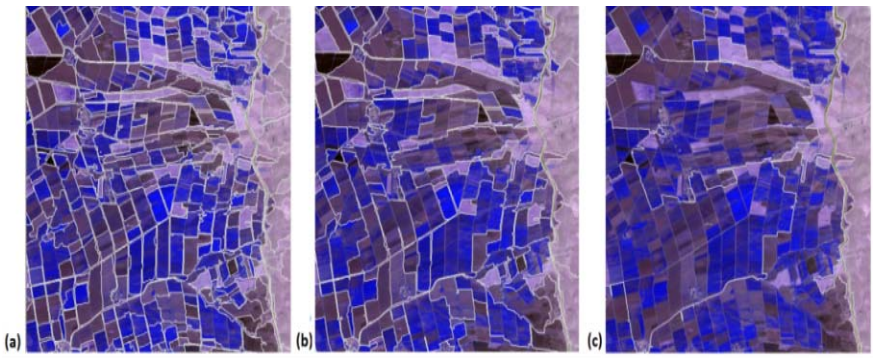
- The basic processing units of object-oriented image analysis are segments (also called image objects). During the segmentation process, image is subdivided into **segments** and then these objects are classified.
- The scale and heterogeneity criteria control the outcome of the segmentation algorithm.
  - **The scale parameter** defines the size of the image object, therefore different scale values are used for different data sets and different objects.
  - **Heterogeneity criterion** is computed using spectral or non-spectral layers and this criterion controls the merging decision.
- Different segmentation parameters were tested and their results were examined visually to find out the best parameter settings for this research. Multi resolution image segmentation with the **scale parameter 50** was found appropriate to identify the agriculture parcels
- **The color criterion: 0.7**
- **Shape : 0.3.**
- **Compactness and smoothness parameters** (that defines heterogeneity criterion): **0.5**.



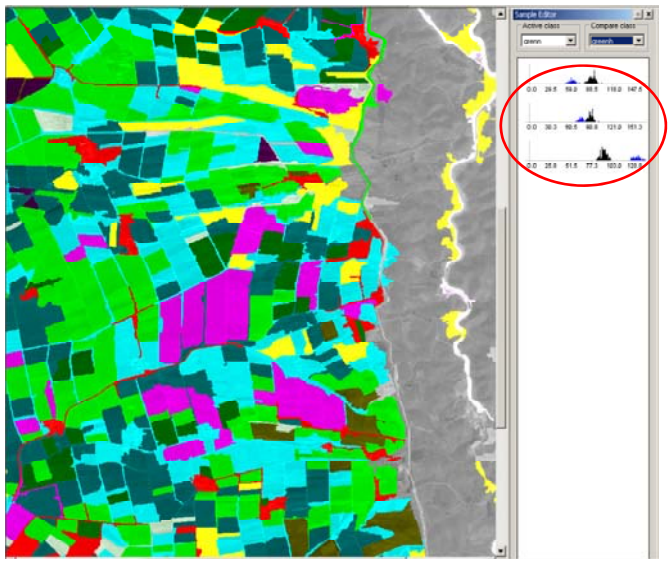
Scale parameter analysis and Image segmentation step

An example of segmentation result with unsuitable color and shape parameter



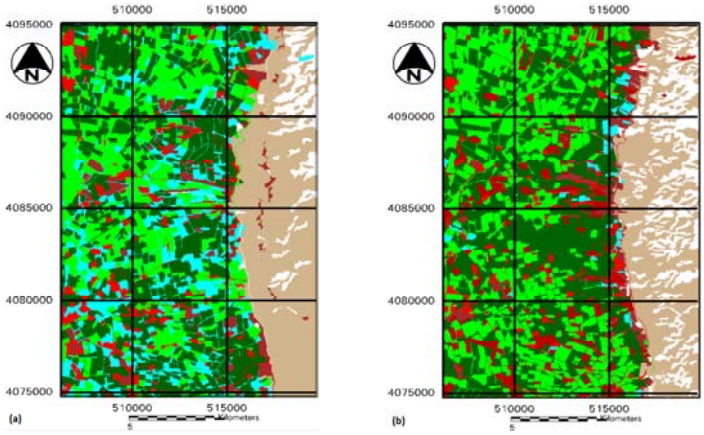


Multiresolution image segmentation at different scales; a) 50, b) 100 and c) 500



Spectral Histograms of image objects taken as samples in Nearest Neighbour Object based Classification
(green(blue) for corn; greenh(black) for cotton)

- Image objects were extracted as the result of this segmentation process. The defined image objects were compared with ground truth and the verified objects were used as classification samples in the nearest neighbor classification step. Classification samples of a class were selected considering the homogenous distribution of samples in the study area and probability histogram of the class which is generated automatically by adding samples. In the next step, classification process was performed using collected sampling objects.



Nearest neighbor object based classification results of; a) 22-07-2009 dated and b) 24-09-2009 dated SPOT 5 satellite images (Dark Green: Cotton; Green: Corn; Magenta: straw; Brown: empty parcels, tan: Bare soil, white: dry river channels).

Accuracy Assessment

- Point based accuracy assessment in test areas including cotton, corn, straw, soil, empty parcels and river channels.
- 100 points/pixels were randomly selected within the test areas and classified value and ground truth value of each pixel were compared. Common points were used for each classification.
  - 20 points for cotton class,
  - 20 points for corn class,
  - 15 points per each other classes.

22.07.2009 Dated Unsupervised Classification

Classified Data	COTTON	CORN	STRAW	EMPTY	BARE	RIVER	Row Total
COTTON	17	1	1	0	0	0	19
CORN	1	16	1	0	2	1	21
STRAW	0	0	12	1	0	0	13
EMPTY	2	0	0	14	0	1	17
BARE	0	0	0	0	13	0	13
RIVER	0	3	1	0	0	13	17
Column Total	20	20	15	15	15	15	100

Error Matrix

Accuracy Table

Class Name	Reference Totals	Classified Totals	Number Correct	Producers Accuracy	Users Accuracy
COTTON	20	19	17	85,00%	89,47%
CORN	20	21	16	80,00%	76,19%
STRAW	15	13	12	80,00%	92,31%
EMPTY	15	17	14	93,33%	82,35%
BARE	15	13	13	86,67%	100,00%
RIVER	15	17	13	86,67%	76,47%
Totals	100	100	85		

Overall Classification Accuracy = 85.00%

22.07.2009 Dated Supervised Classification

Classified Data	COTTON	CORN	STRAW	EMPTY	BARE	RIVER	Row Total
COTTON	15	1	1	0	0	1	18
CORN	1	16	1	1	2	1	22
STRAW	1	0	12	1	0	0	14
EMPTY	2	0	0	13	1	1	17
BARE	1	0	0	0	12	0	13
RIVER	0	3	1	0	0	12	16
Column Total	20	20	15	15	15	15	100

Error Matrix

Accuracy Table

Class Name	Reference Totals	Classified Totals	Number Correct	Producers Accuracy	Users Accuracy
COTTON	20	18	15	75,00%	83,33%
CORN	20	22	16	80,00%	72,73%
STRAW	15	14	12	80,00%	85,71%
EMPTY	15	17	13	86,67%	76,47%
BARE	15	13	12	80,00%	92,31%
RIVER	15	16	12	80,00%	75,00%
Totals	100	100	80		

Overall Classification Accuracy = 80.00%

22.07.2009 Dated Object Based Classification

Classified Data	COTTON	CORN	STRAW	EMPTY	BARE	RIVER	Row Total
COTTON	17	1	1	0	1	1	21
CORN	2	17	0	0	0	1	20
STRAW	0	0	14	0	0	0	14
EMPTY	0	1	0	15	0	0	16
BARE	1	1	0	0	13	0	15
RIVER	0	0	0	0	1	13	14
Column Total	20	20	15	15	15	15	100

Error Matrix

Accuracy Table

Class Name	Reference Totals	Classified Totals	Number Correct	Producers Accuracy	Users Accuracy
COTTON	20	21	17	85,00%	80,95%
CORN	20	20	17	85,00%	85,00%
STRAW	15	14	14	93,33%	100,00%
EMPTY	15	16	15	100,00%	93,75%
BARE	15	15	13	86,67%	86,67%
RIVER	15	14	13	86,67%	92,86%
Totals	100	100	89		

Overall Classification Accuracy = 89.00%

24.09.2009 Dated Unsupervised Classification

Classified Data	COTTON	CORN	STRAW	EMPTY	BARE	RIVER	Row Total
COTTON	16	2	0	0	1	0	19
CORN	1	15	1	1	2	1	21
STRAW	0	0	14	1	0	0	15
EMPTY	0	2	0	13	0	1	16
BARE	2	0	0	0	12	0	14
RIVER	1	1	0	0	0	13	15
Column Total	20	20	15	15	15	15	100

Error Matrix

Accuracy Table

Class Name	Reference Totals	Classified Totals	Number Correct	Producers Accuracy	Users Accuracy
COTTON	20	19	16	80,00%	84,21%
CORN	20	21	15	75,00%	71,43%
STRAW	15	15	14	93,33%	93,33%
EMPTY	15	16	13	86,67%	81,25%
BARE	15	14	12	80,00%	85,71%
RIVER	15	15	13	86,67%	86,67%
Totals	100	100	83		

Overall Classification Accuracy = 83.00%

24.09.2009 Dated Supervised Classification

Classified Data	COTTON	CORN	STRAW	EMPTY	BARE	RIVER	Row Total
COTTON	16	1	1	0	1	1	20
CORN	0	17	0	1	2	0	20
STRAW	1	0	11	0	1	1	14
EMPTY	2	0	0	14	0	0	16
BARE	1	0	2	0	11	0	14
RIVER	0	2	1	0	0	13	16
Column Total	20	20	15	15	15	15	100

Error Matrix

Accuracy Table

Class Name	Reference Totals	Classified Totals	Number Correct	Producers Accuracy	Users Accuracy
COTTON	20	20	16	80,00%	80,00%
CORN	20	20	17	85,00%	85,00%
STRAW	15	14	11	73,33%	78,57%
EMPTY	15	16	14	93,33%	87,50%
BARE	15	14	11	73,33%	78,57%
RIVER	15	16	13	86,67%	81,25%
Totals	100	100	82		

Overall Classification Accuracy = 82.00%

24.09.2009 Dated Object Based Classification

Classified Data	COTTON	CORN	STRAW	EMPTY	BARE	RIVER	Row Total
COTTON	18	1	0	0	0	0	19
CORN	2	15	0	1	0	2	20
STRAW	0	0	14	0	0	0	14
EMPTY	0	1	0	14	1	0	16
BARE	0	2	0	0	13	0	15
RIVER	0	1	1	0	1	13	16
Column Total	20	20	15	15	15	15	100

Error Matrix

Accuracy Table

Class Name	Reference Totals	Classified Totals	Number Correct	Producers Accuracy	Users Accuracy
COTTON	20	19	18	90,00%	94,74%
CORN	20	20	15	75,00%	75,00%
STRAW	15	14	14	93,33%	100,00%
EMPTY	15	16	14	93,33%	87,50%
BARE	15	15	13	86,67%	86,67%
RIVER	15	16	13	86,67%	81,25%
Totals	100	100	87		

Overall Classification Accuracy = 87.00%

Summary

	22.07.2009 Dated Classifications		
	Unsupervised	Supervised	Object Based
Accuracy	85,00%	80,00%	89,00%
Kappa	0.7875	0.7595	0.8385
	24.09.2009 Dated Classifications		
	Unsupervised	Supervised	Object Based
Accuracy	83,00%	82,00%	87,00%
Kappa	0.8100	0.8036	0.8430

RESULTS

- Classification of remotely sensed data gives valuable information in agricultural activities in terms of crop type identification and crop area identification.
- Evaluation results with visual interpretation illustrated that all classification techniques reached a reasonable accuracy in crop type determination and spatial locations of the crop types were mostly determined.
- Object based classification technique results gave more accurate information in determining the agricultural parcels in terms of homogeneity and shape as a result of generating image objects with image segmentation.

RESULTS

- Pixel based classification techniques failed to determine the borders of agriculture parcels especially in which the parcel held different surface cover having heterogeneous reflectance. On the other hand, each segment created in object based classification has a unique value, so differences of surface patterns inside the segment cannot be designated.
- The results indicated that, acceptable identification performance of crop areas can be obtained by using both pixel based and object based classification techniques. Object based classification results gave superior results compared to pixel based classification techniques.

Thank you

Prof.Dr.Cankut ORHAN