International Workshop

Wisdom on Land and Water Management – Designing Local Framework of Integrated Resources Management Use

13-15 November 2011, RIHN, Kyoto

Competitive Funding for Team-based Basic Researches

Using Geo-spatial technologies for land-water resource management: Seyhan Basin case study

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ÇUKUROVA UNIVERSITY

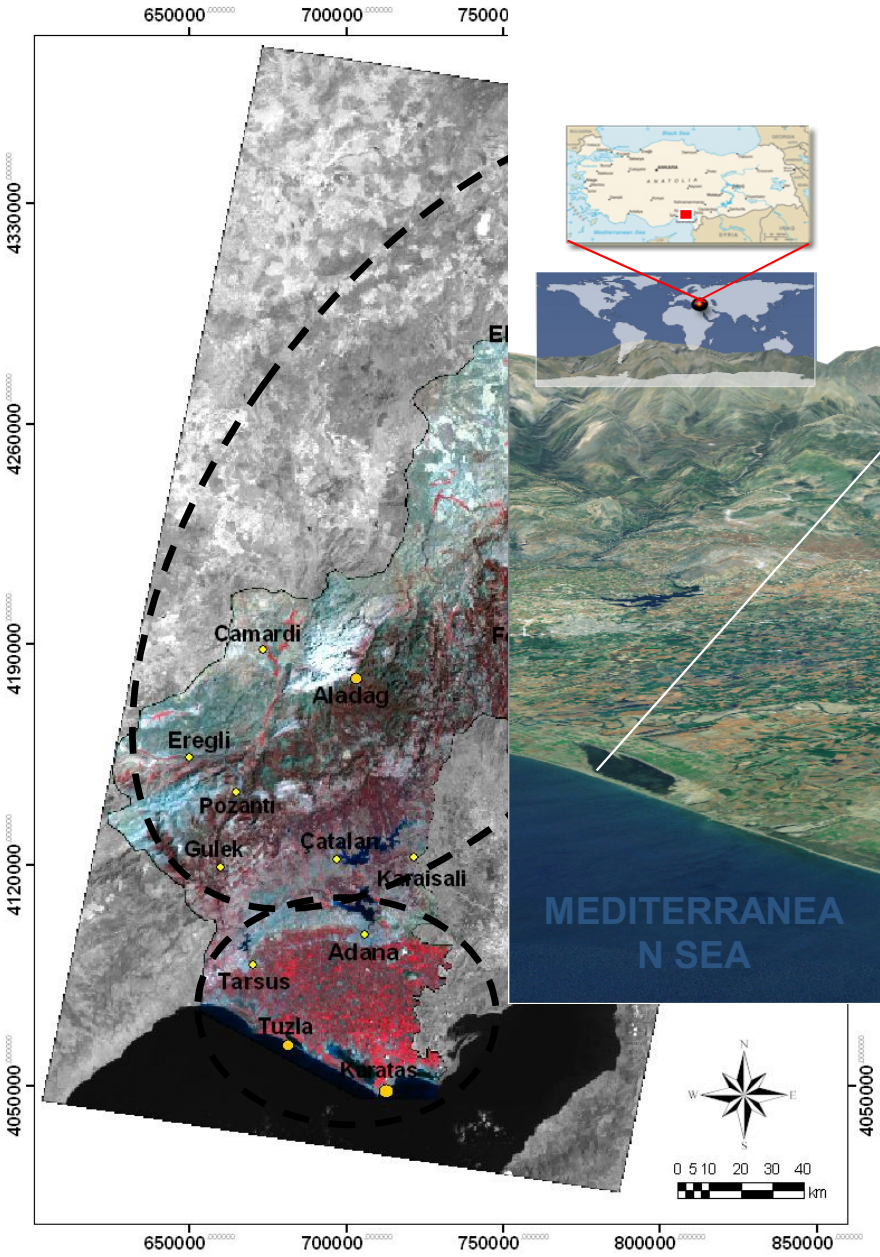
LANDSCAPE ARCHITECTURE

REMOTE SENSING AND GIS LABORATORY

CONTENTS OF THE PRESENTATION

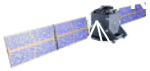
1. Problems

- Erosion
- Deforestation
- Deterioriation of water quality
- A coal-fired (thermal) power plant is planned around Tufanbeyli Town
- Improper land use
- Exces use of fertilizers & pesticides
- Exces use of water



2. Lower Seyhan Plain (LSP)

- Salinity
- Crop productivity
- Mapping & Monitoring Agricultural Land Use Pattern
- Land use modelling



3. Akarsu Irrigation District

Field measurements for water budget & quality (EC)

irrigation return flow measurements

Socio-economic structure

1. Upper Basin

- **Hydrological Dynamics**
- **Net Primary Productivity (NPP)**
- **Erosion**

Modelling Mountain Hydrological System Dynamics : J2000

Climate Variables

- ***Tmin, Tmax, Tmean***
- ***Rhum***
- ***Sunh***
- ***Precipitation***

Runoff

HRUs

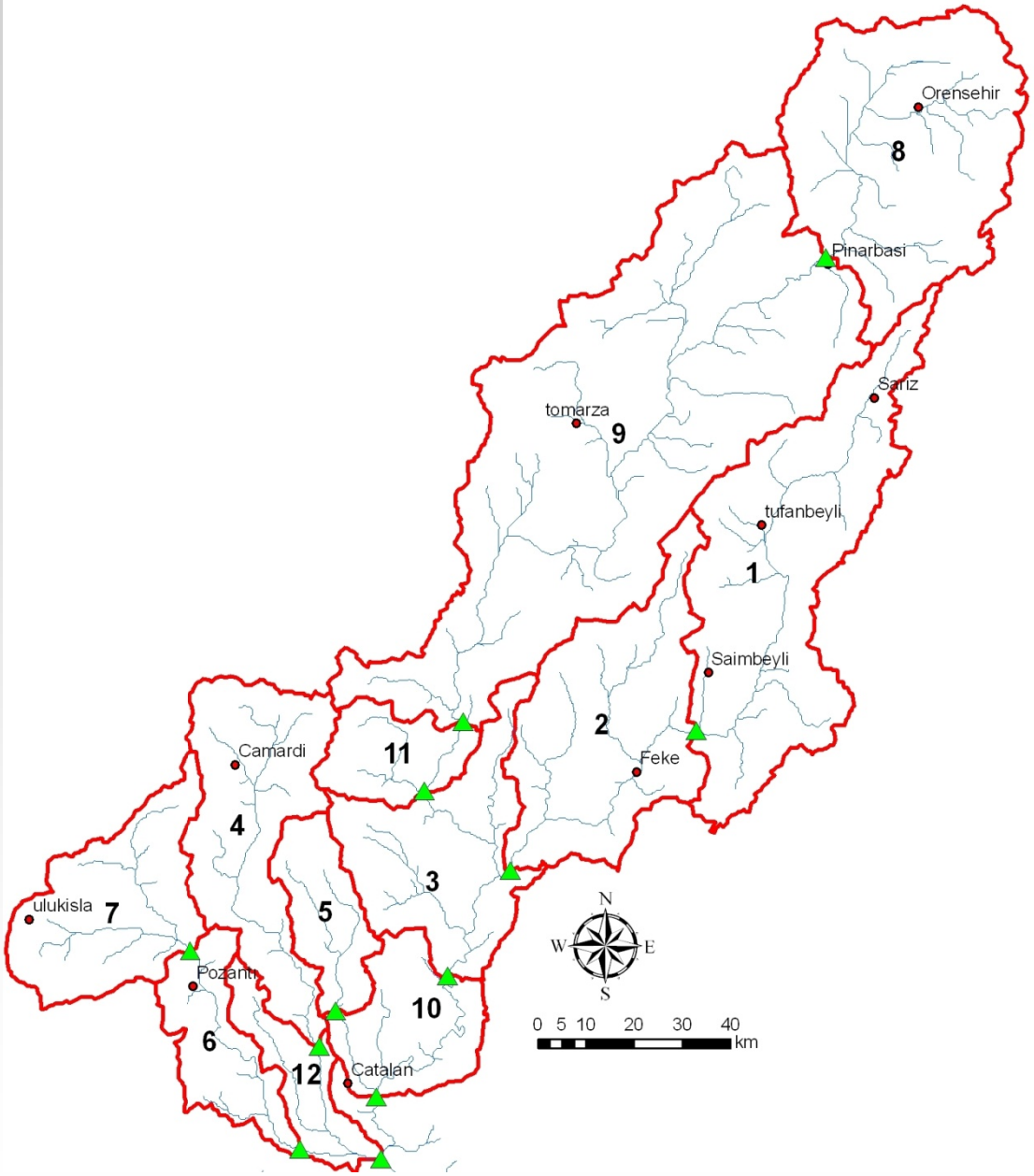
Landuse

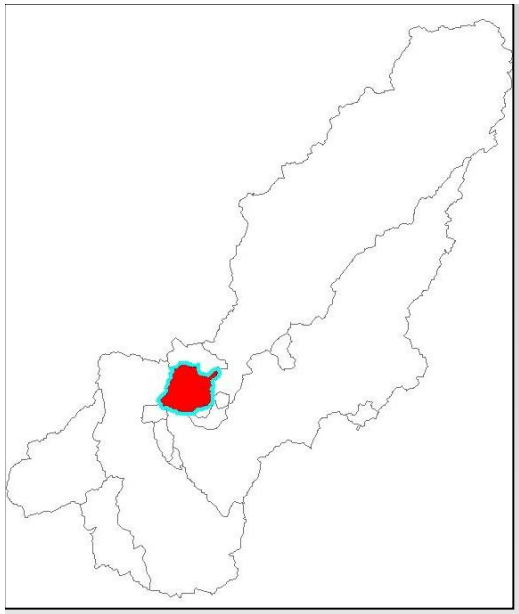
Soils

Geology

12 sub-catchments

Sub-catchment names	Area (km^2)
1. Himmetli	2549.90
2. Gökdere	1784.39
3. Ergenuşağı	1185.77
4. Üçtepe	1313.05
5. Hacılıköprü	**1435.93**
6. Sarıahmetli	766.29
7. Emeğli	2394.24
8. Eğribük	552.76
9. Değirmenocağı	5368.95
10. Çakıt Suyu	650.57
11. Karakuz	513.00
12. Kılıçmehmet	469.97



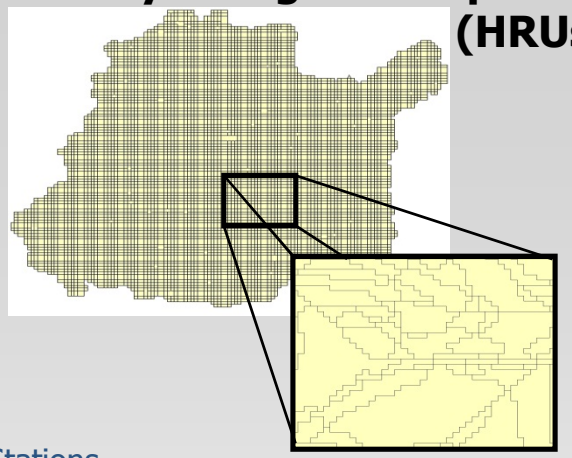


Hacilikopru Subcatchment

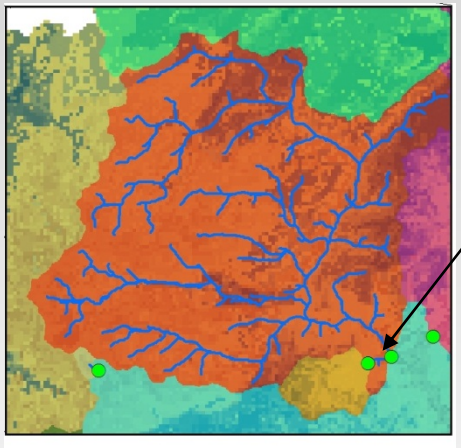
Mountaneous region, karstic system

Cover – 356.89 km2

Hydrological Response Units (HRUs)



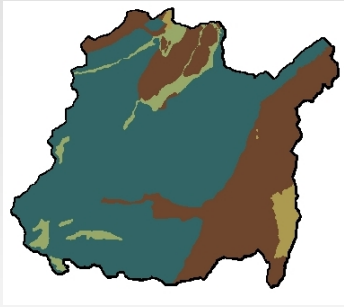
Stream Network



1 Gauging Stations

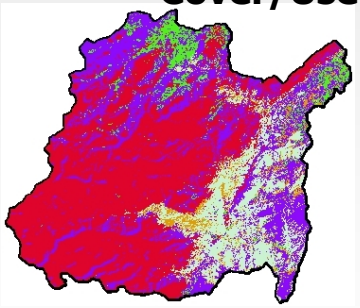
Runoff (1995 – 2002)

Geology



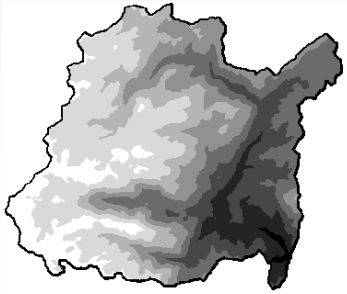
Aspect

Land Cover/Use

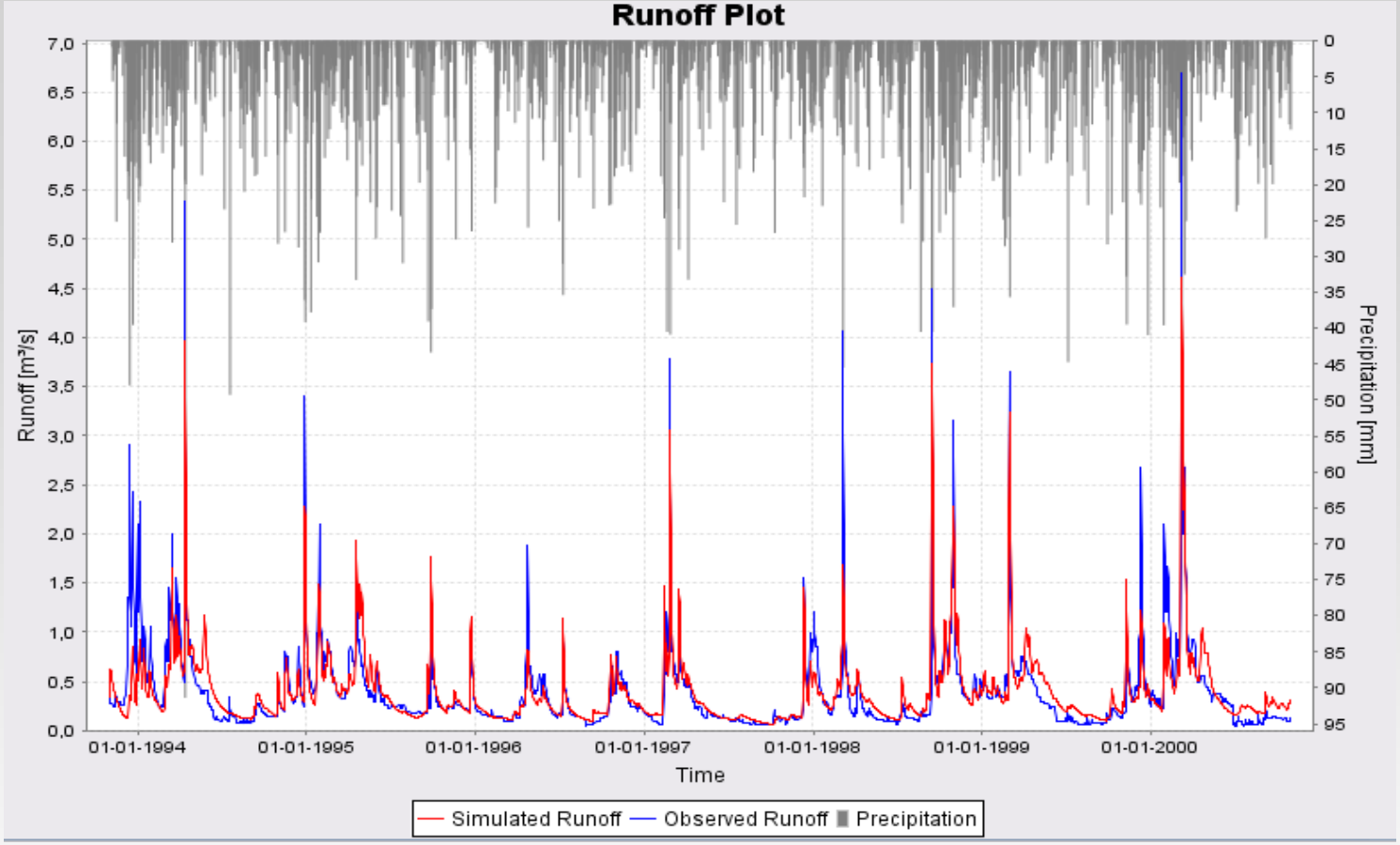


Soils

Elevation



Slope



Results for Hacilikopru Subcatchment

R^2= 0.75

RMSE = 0.23

Nash-Sutcliffe Efficiency (e2)= 0.57

Results for Hacilikopru Subcatchment

Hydrological Quantities(mm) (Model Res.)	*Present*	*2070-2099*
Precipitation	*767.09*	*536.96*
ET	444.32	437.52
Runoff	341.94	222.59
GW-Upper Zone (RG1)	79.98	46.55
GW-Lower Zone(RG2)	30.73	17.89
Soil-Water (MPS)	83.29	51.64
Soil-Water (LPS)	75.99	47.11
Interception	51.11	48.60

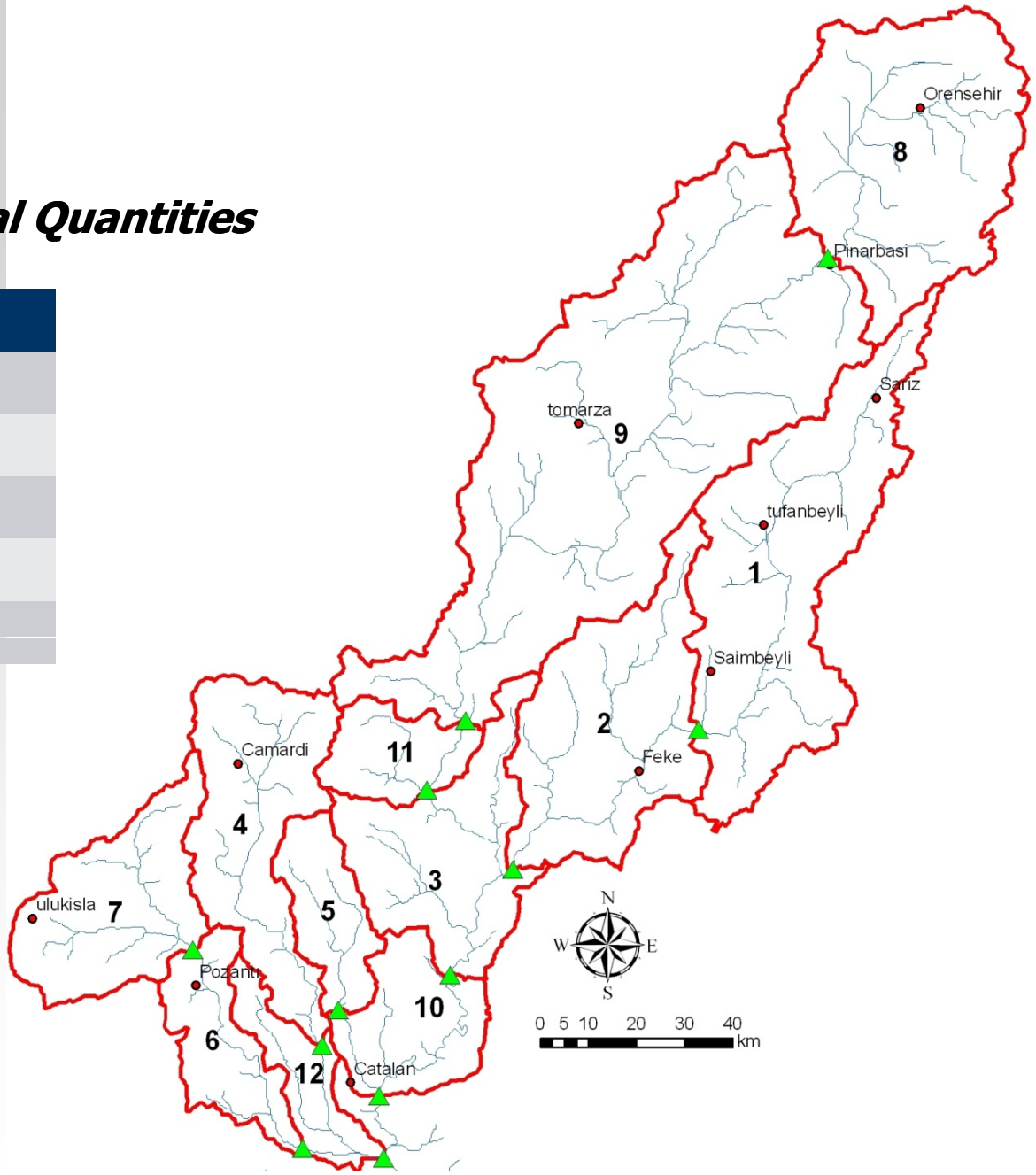
- **Total Runoff, 0.401 km^3**

- **Precipitation decrease, 0.230 km^3,**
- **Runoff Decrease 0.710 km^3 azalma**

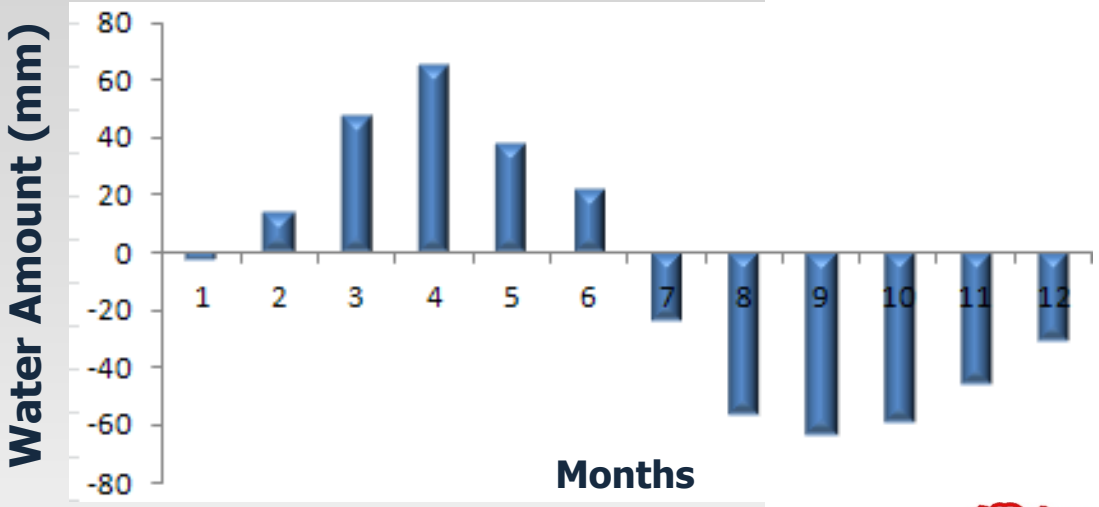
Hydrological Quantities (km3) (Model Res.)	**Present**	**2070-2099**
Precipitation	1.01	0.779
ET	0.468	0.454
Runoff	0.401	0.330
GW	0.043	0.032
Soil-Water	0.127	0.99
Interception	0.023	0.020

Ratios of The Hydrological Quantities

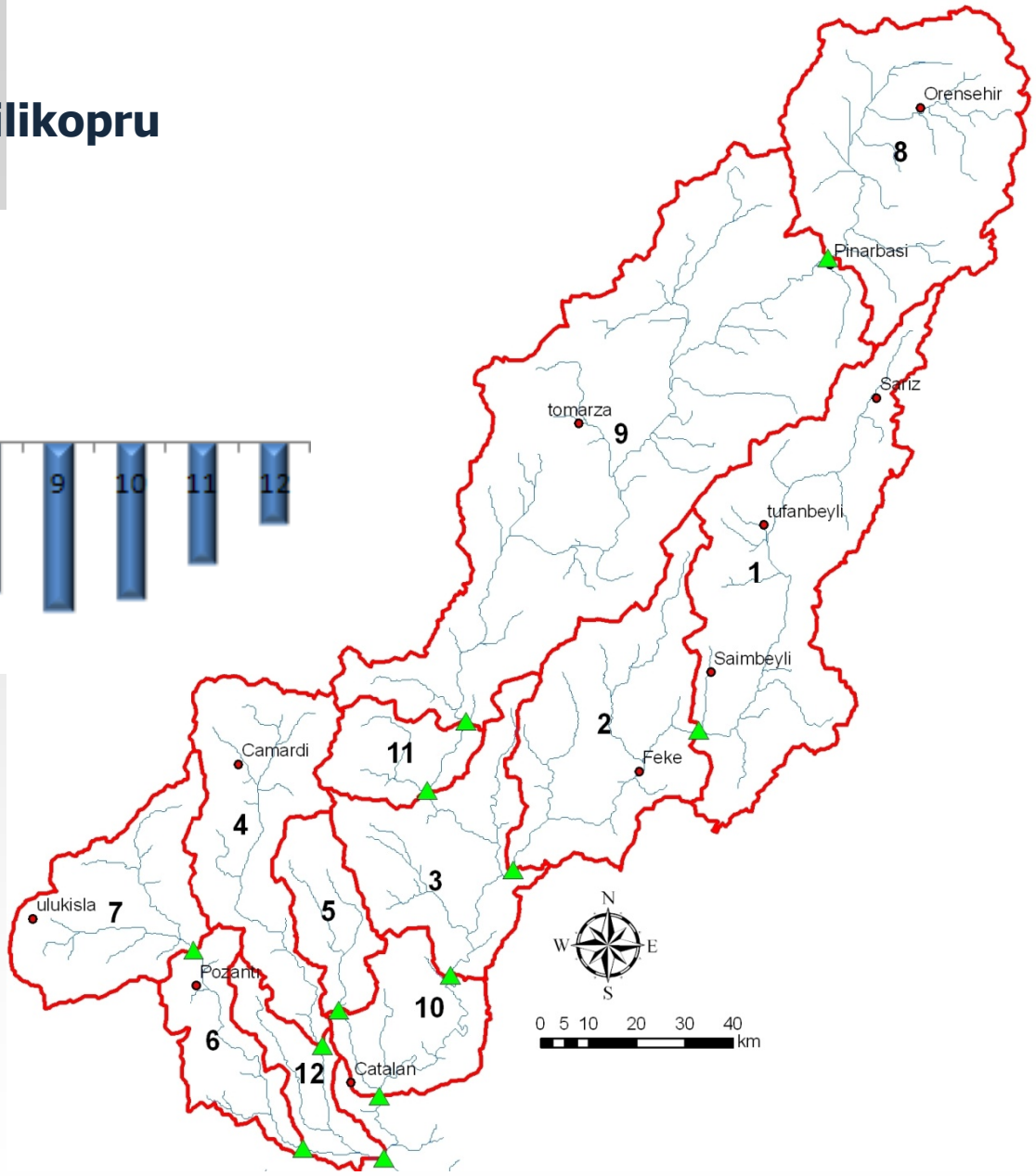
Quantity	Ratio (%)
ET	46
Runoff	40
GW	6
Soil-Water	14
Interception	2



Water Balance of Hacilikopru



1.01 km3 water income
1.06 km3 outcome



1. Upper Basin

- Hydrological Dynamics
- Net Primary Productivity (NPP)
- Erosion

Net Primary Productivity:

The remainder of photosynthesis and respiration

Gross primary productivity (GPP): is the total amount of atmospheric carbon (CO_2) assimilated by vegetation.
Net primary productivity (NPP): includes maintenance and growth respiration costs to the plant, and is therefore the net assimilation of atmospheric CO_2 into organic matter.

$$NPP = GPP - respiration$$

NASA – CASA (Carnegie-Ames-Stanford Approach)

$$NPP = APAR \times \varepsilon$$

$$NPP = f(NDVI) \times PAR \times \varepsilon^* \times g(T) \times h(W)$$

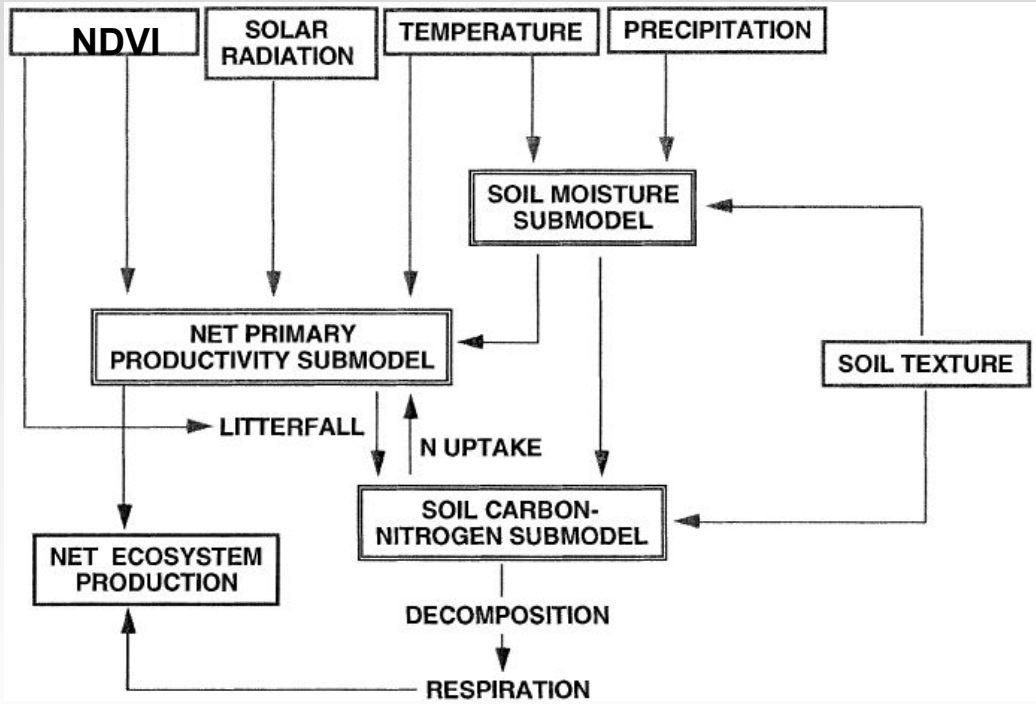
APAR: Absorbed Photosynthetically Active (400 to 700) Solar Radiation

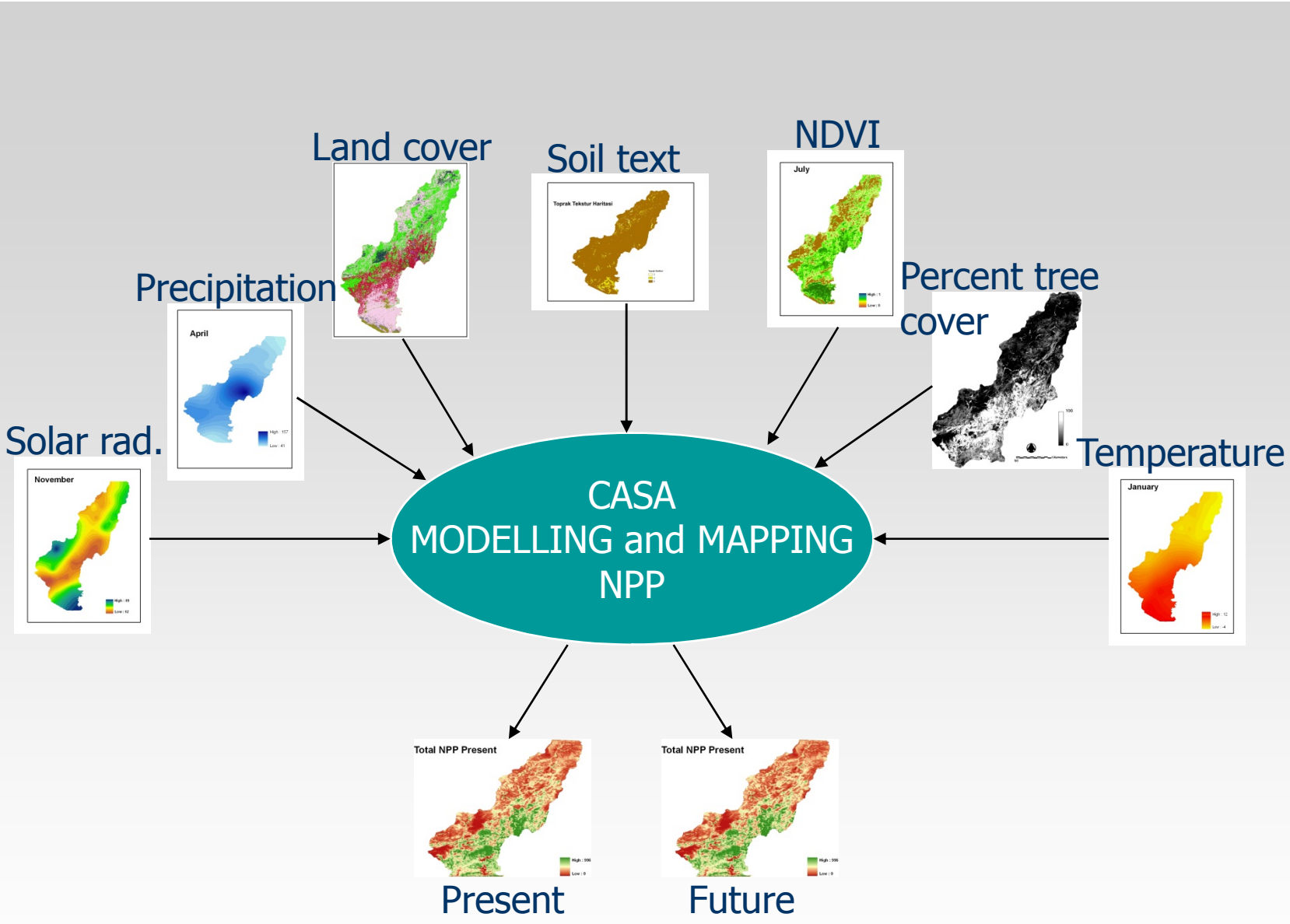
ε Average Light Utilization Efficiency

***g*(*T*): effects of temperature**

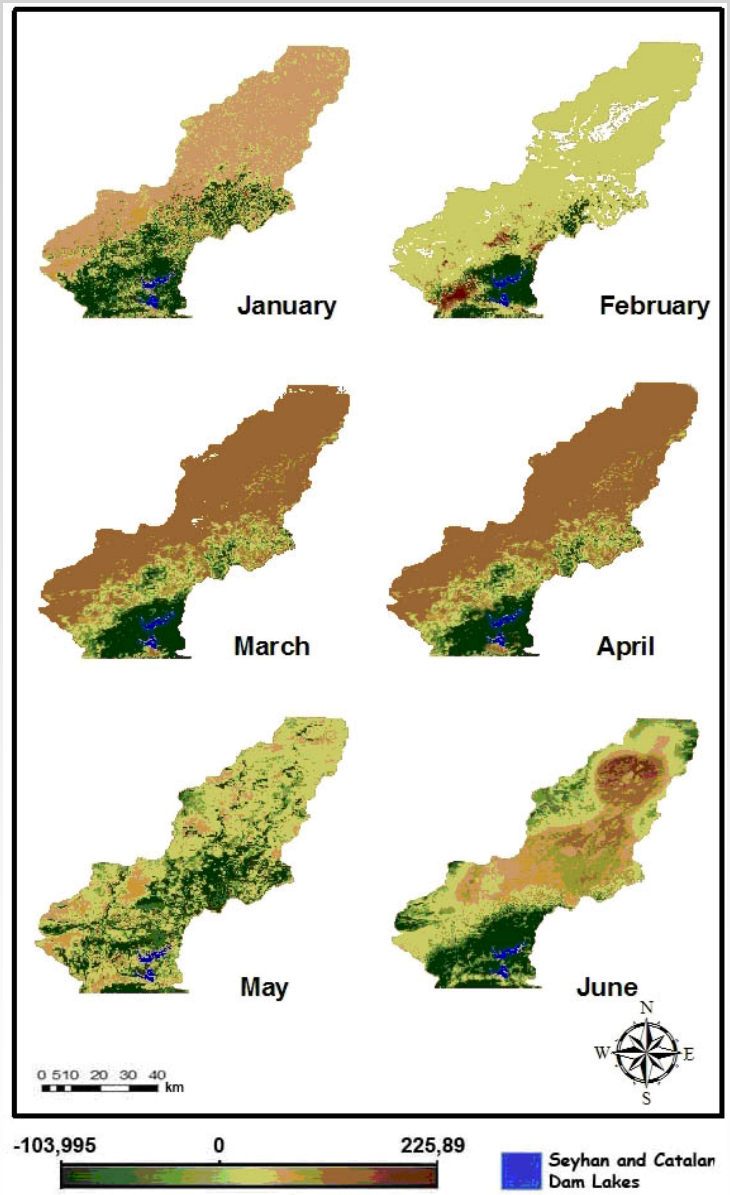
***h*(*W*): water stress (precipitation)**

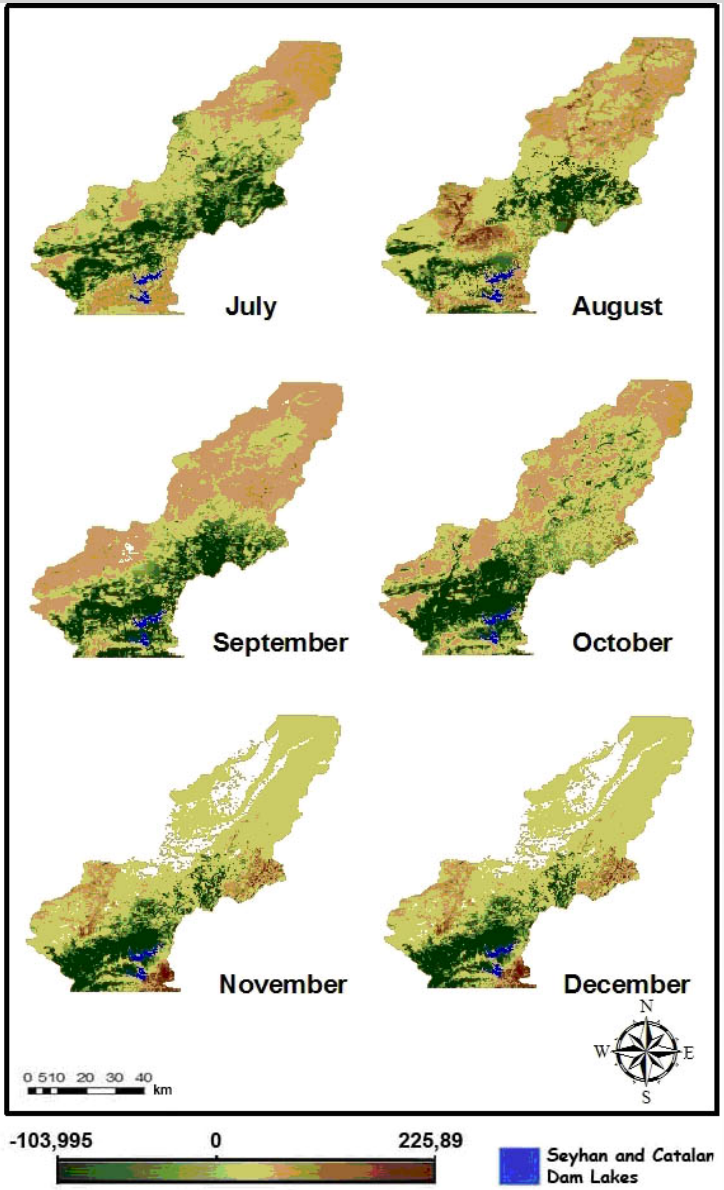
PAR: photosynthetically active solar radiation



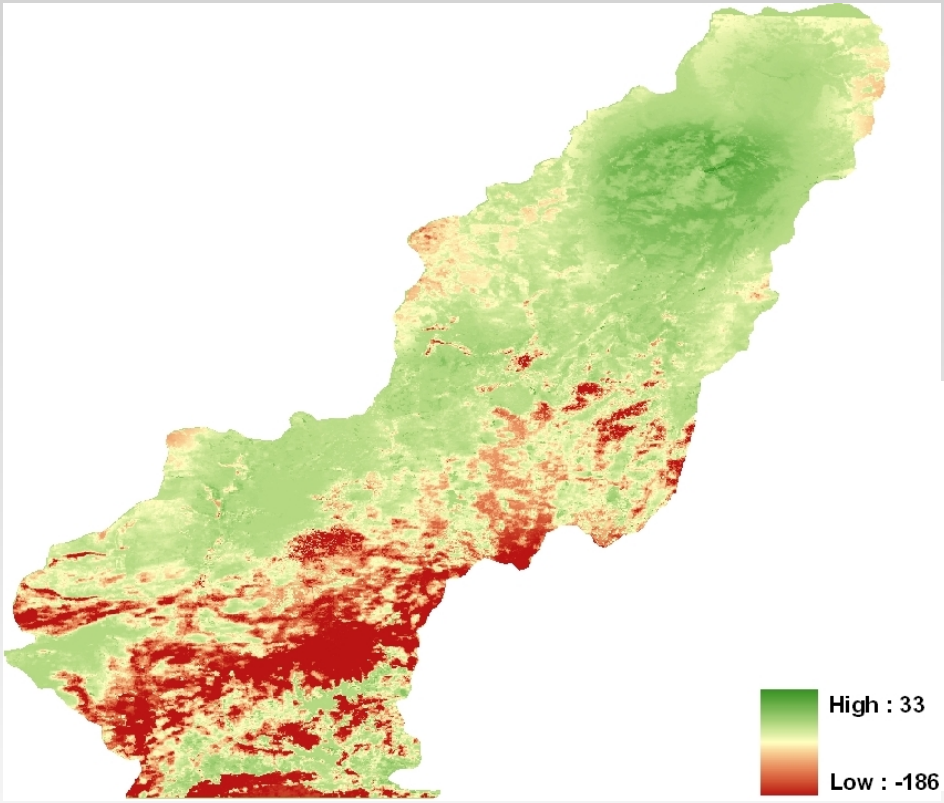

Land cover
Soil text
NDVI
Precipitation
Percent tree cover
Solar rad.
Temperature
CASA
MODELLING and MAPPING
NPP
Total NPP Present
Total NPP Present
Present
Future

Net Primary Production Monthly Difference

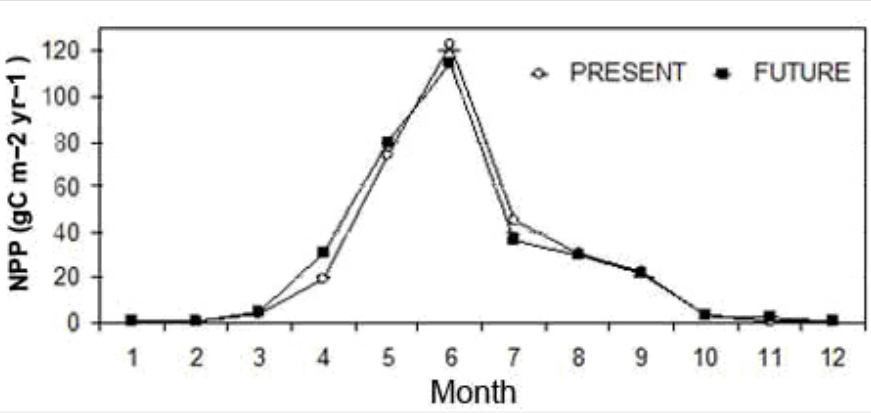




NPP Difference Image



NASA–CASA monthly NPP results



2. Lower Seyhan Plain (LSP)

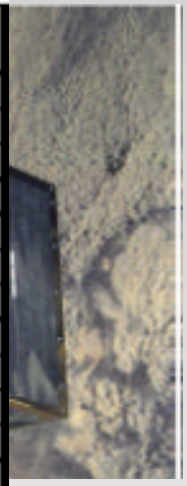
- **Salinity**
- **Mapping & Monitoring Agricultural Land Use Pattern**
- **Crop productivity**
- **Land use modelling**

REMOTELY SENSED DATA

CHRIS PROBA KARA MODU 3

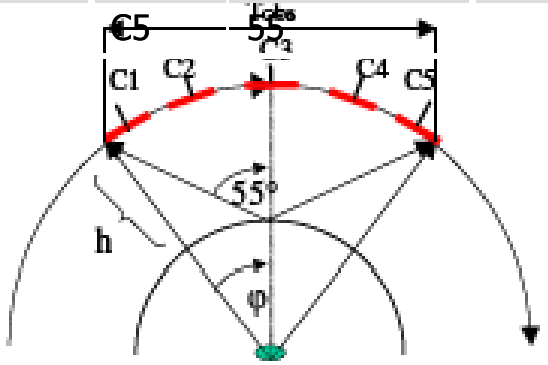
CHRIS PROBA

Band	Min λ (nm)	Max λ (nm)	Mid λ (nm)	Width (nm)
L1	438	447	442	9
L2	486	495	490	9
L3	526	534	530	9
L4	546	556	551	10
L5	566	573	570	8
L6	627	636	631	9
L7	656	666	661	11
L8	666	677	672	11
L9	694	700	697	6
L10	700	706	703	6
L11	706	712	709	6
L12	738	745	742	7
L13	745	752	748	7
L14	773	788	781	15
L15	863	881	872	18
L16	891	900	895	10
L17	900	910	905	10
L18	1002	1035	1019	33



m
m
X15km

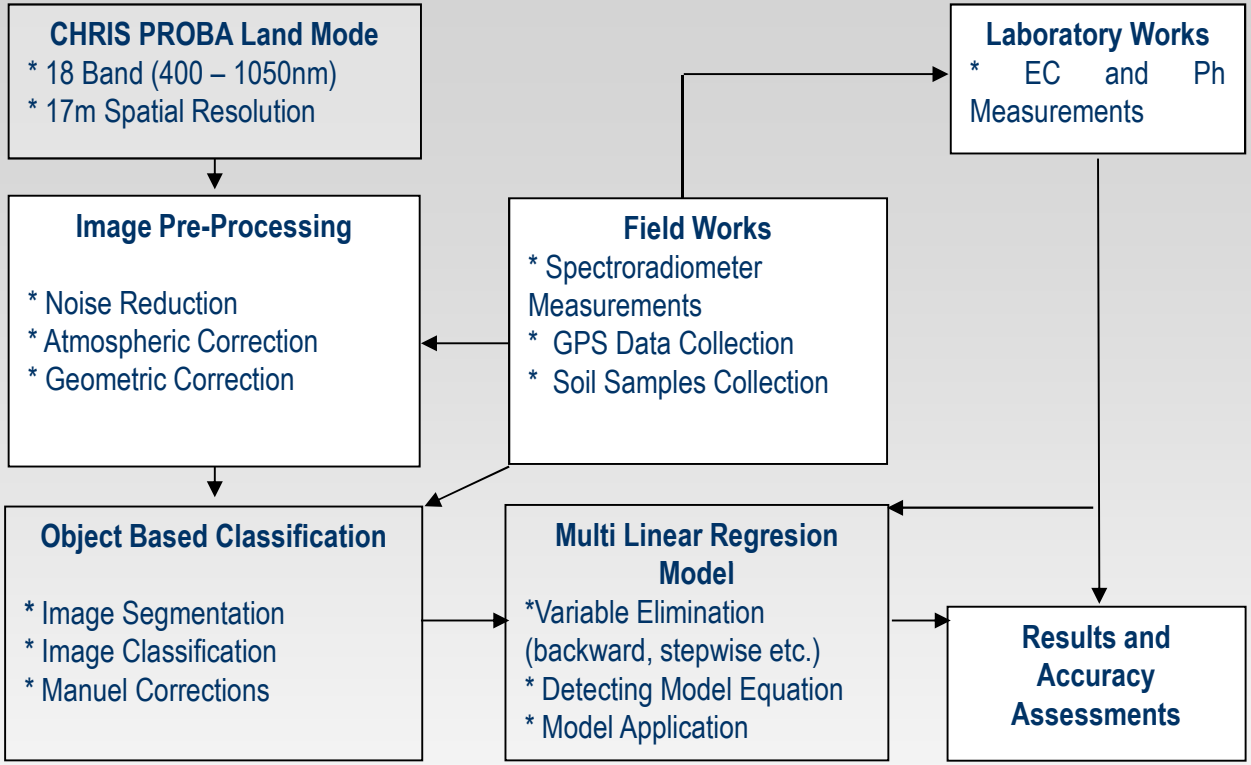
code	angle
C1	-55°
C2	-36°
C3	0°
C4	36°
C5	55°



MOD	Description	Spectral range	Spatial resolution	BANDs	Swath width
MOD 1	GENERAL MOD	406 – 1003nm	34m	62	15X15 km
MOD 2	WATER	406 – 1036nm	17m	18	15X15 km
MOD 3	LAND	438 – 1035nm	17m	18	15X15 km
MOD 3A	LAND 2	420 – 910nm	17m	18	15X15 km
MOD 4	VEGETATION (CLOROPHYLL)	496 – 796 nm	17m	18	15X15 km
MOD 5	KARA MODU 3	439 – 1036 nm	17m	37	7.5 X 7.5 km

Method

Flow diagram of the project

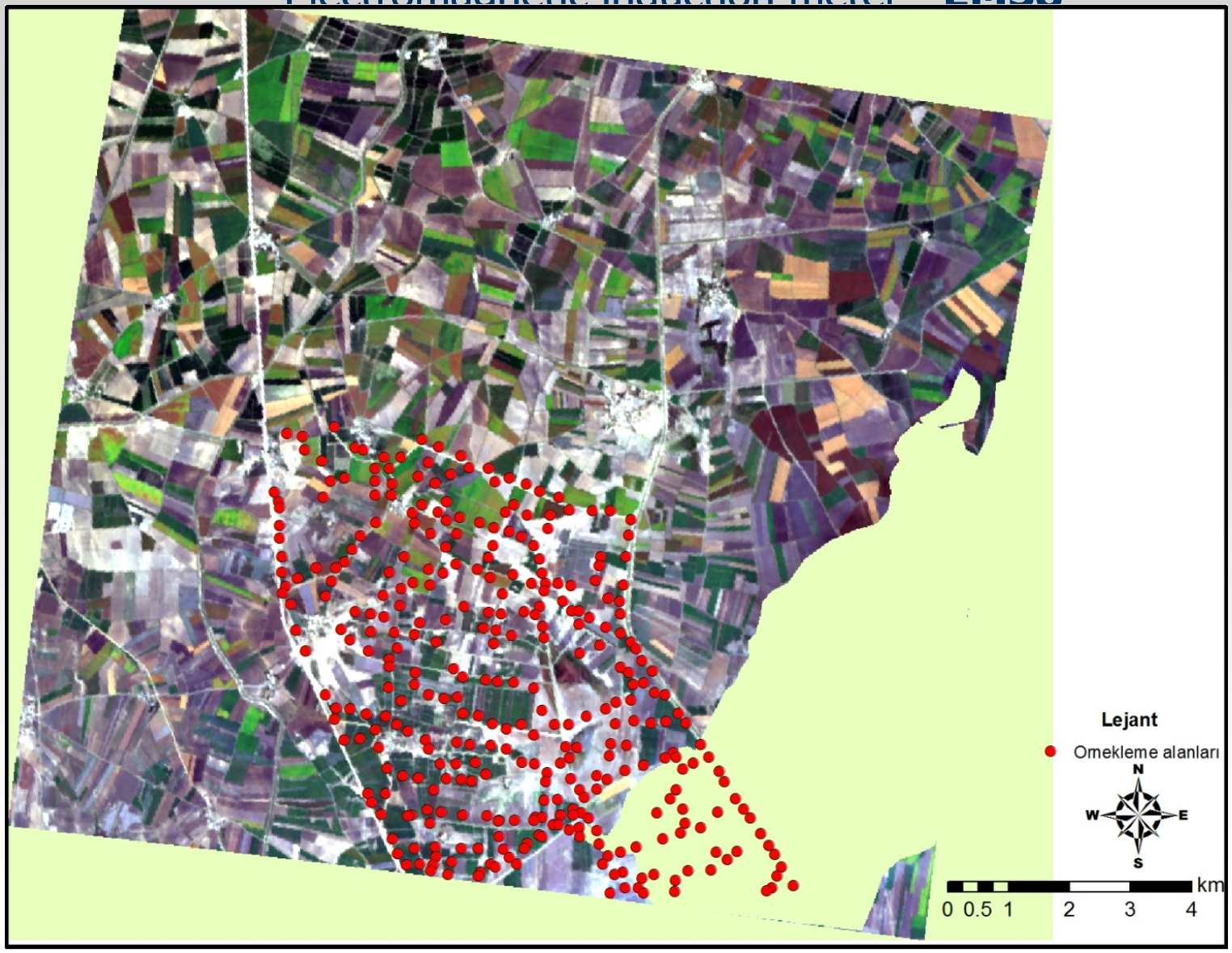


There are five essential steps in this study

1. Field Works
2. Pre-processing of CHRIS data
3. Object based classifications
4. Modeling
5. Accuracy assessments

Soil salinity lectures using

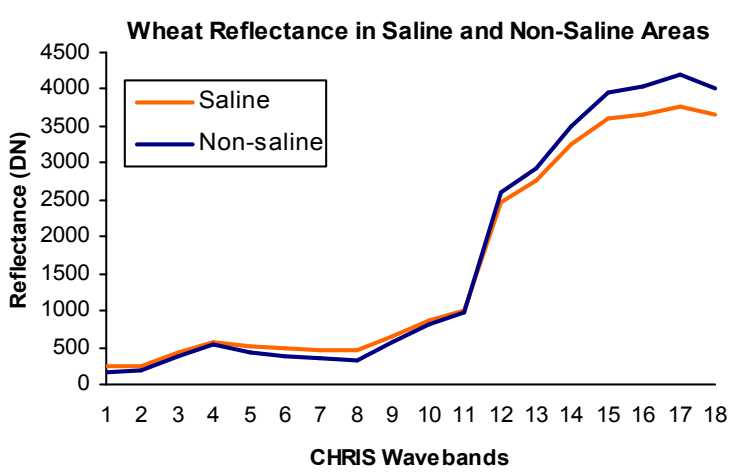
Electromagnetic induction meter - **EM38**

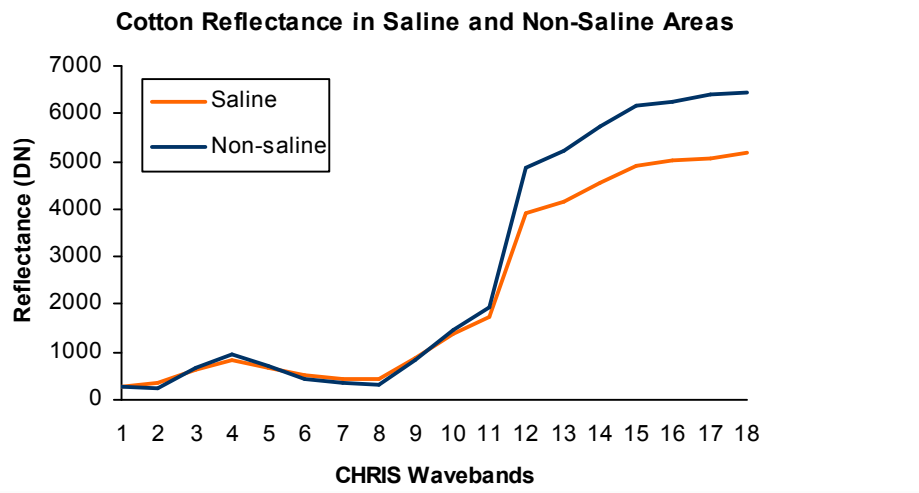


3.4. Modelling

Model summary of the Multi-linear Regression for each field experiment.

DATE	R	R^2	Significance	Std. Error of Estimate	F
26th MAY	0.996	0.993	0.0007	0.1	54.4
15th JULY	0.88	0.77	0.01	0.4	7.76
29th AUGUST	0.95	0.90	0.001	0.5	12.4
11th OCTOBER	0.95	0.91	0.002	0.3	12.6
03rd DECEMBER	0.86	0.74	0.0004	0.4	10.1

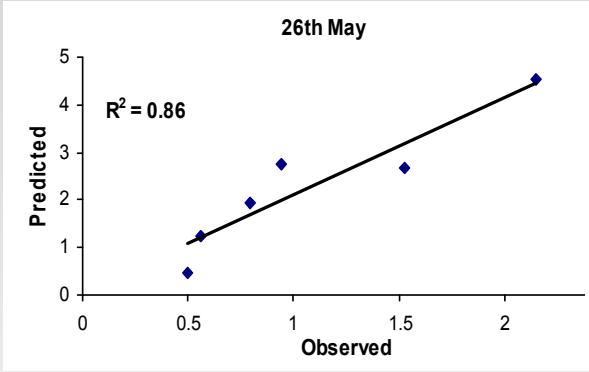


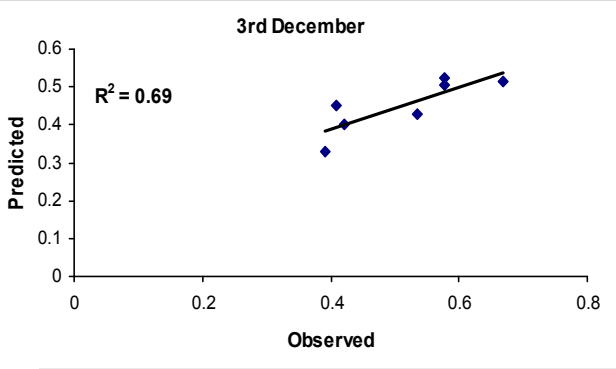


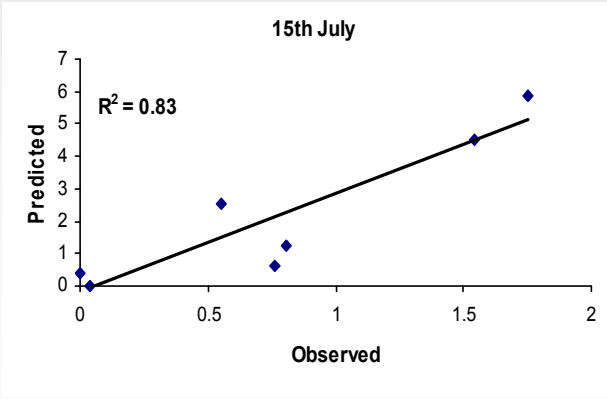
3.5. Accuracy and Results

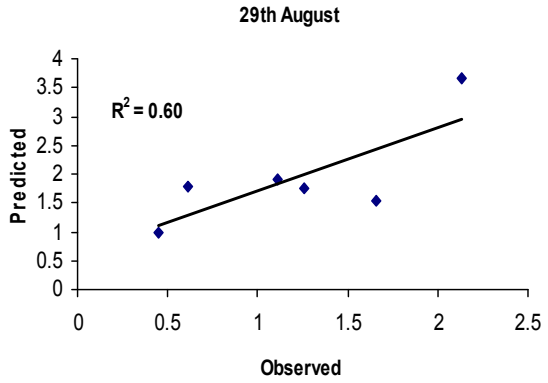
Correlation coefficiency and regression results

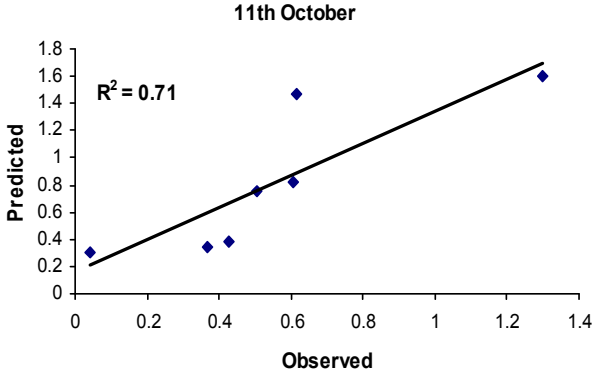
Dates	R	R^2
26th MAY	0.93	0.86
15th JULY	0.91	0.83
29th AUGUST	0.77	0.60
11th OCTOBER	0.84	0.71
03rd DECEMBER	0.83	0.69



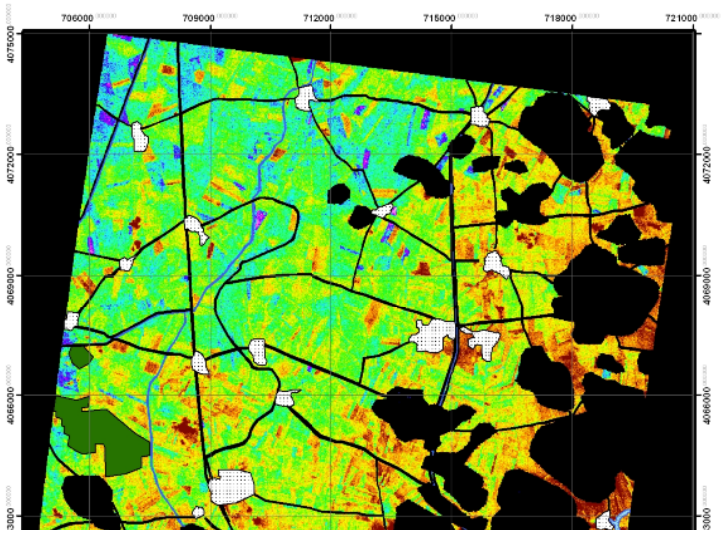




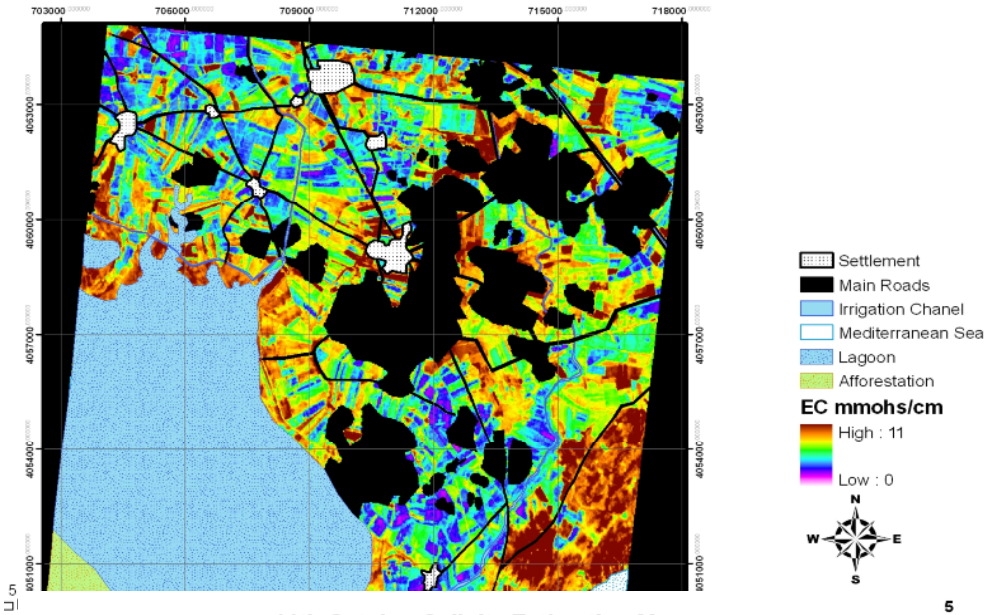




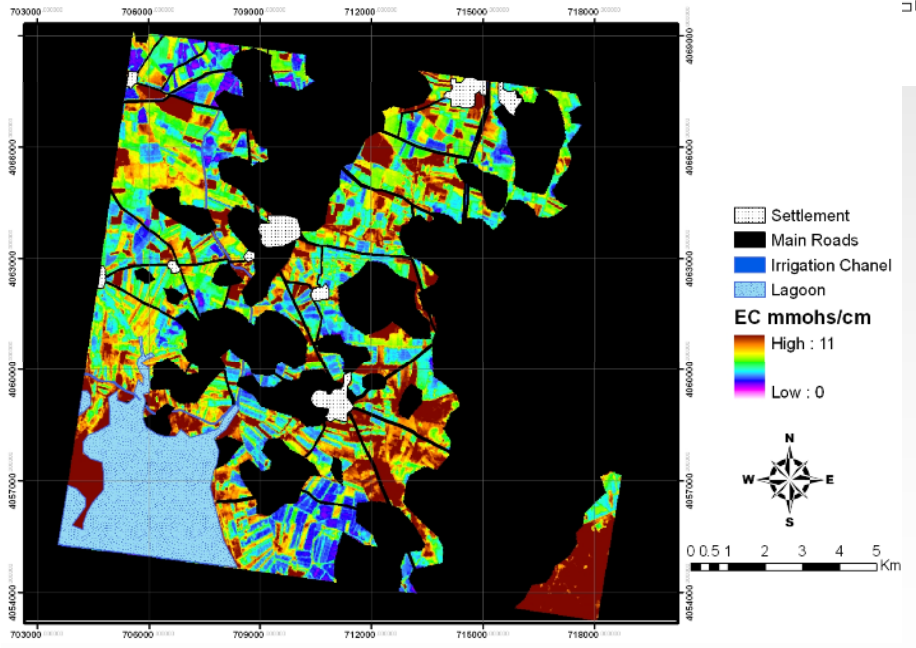
26th May Salinity Estimation Map



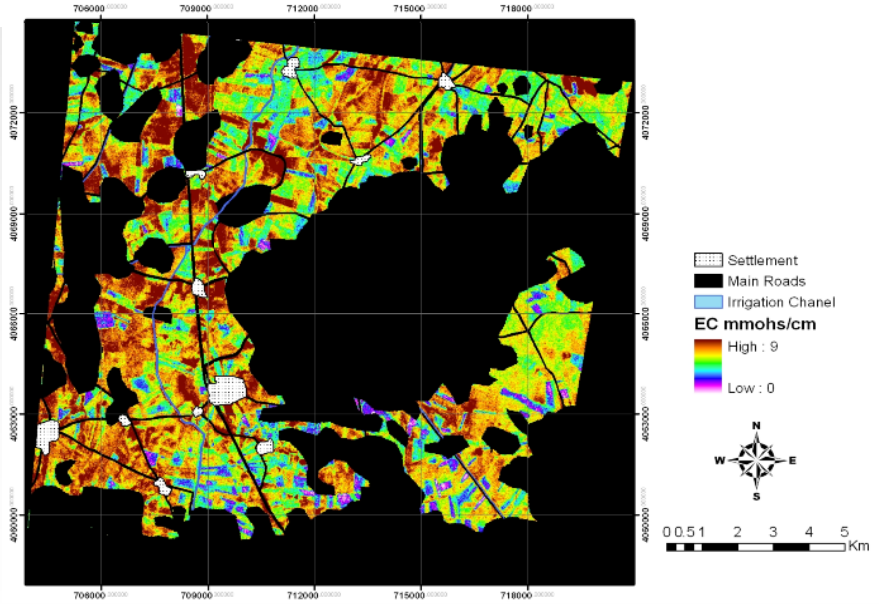
15th July Salinity Estimation Map

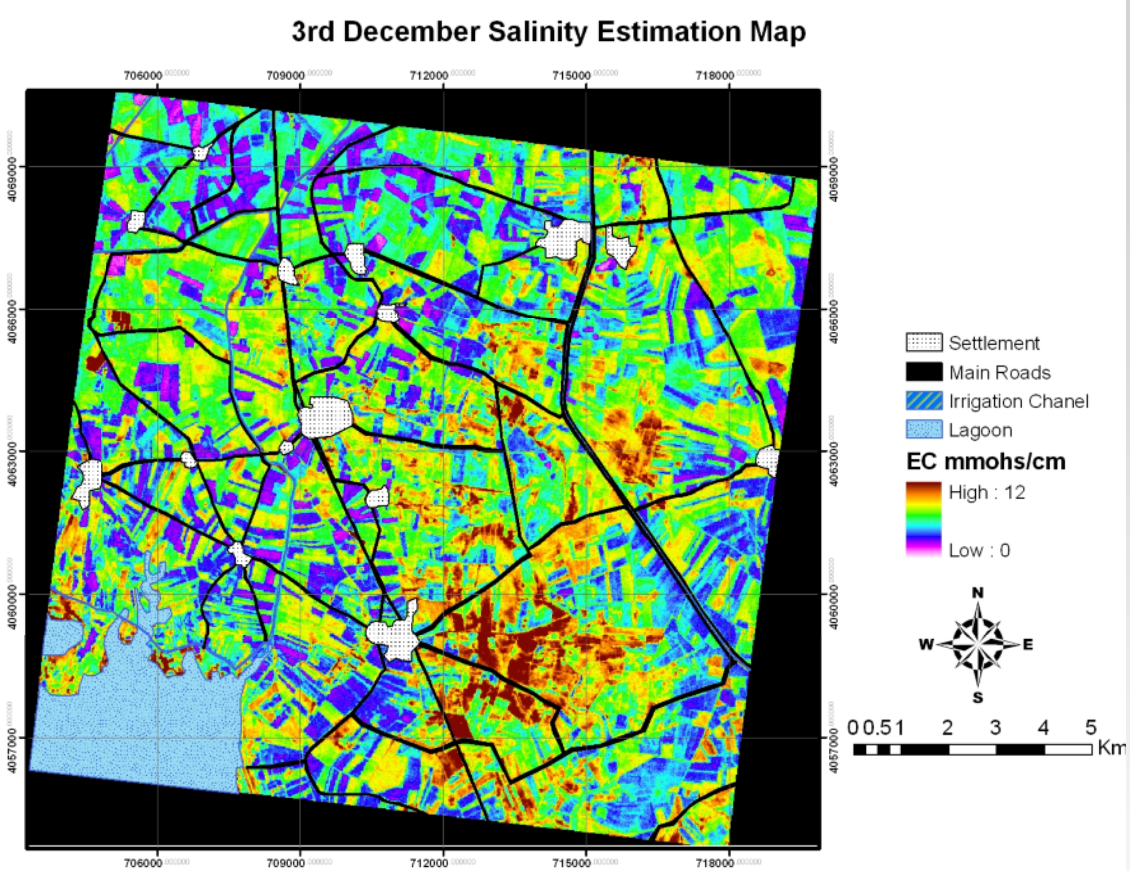


29th August Salinity Estimation Map



11th October Salinity Estimation Map



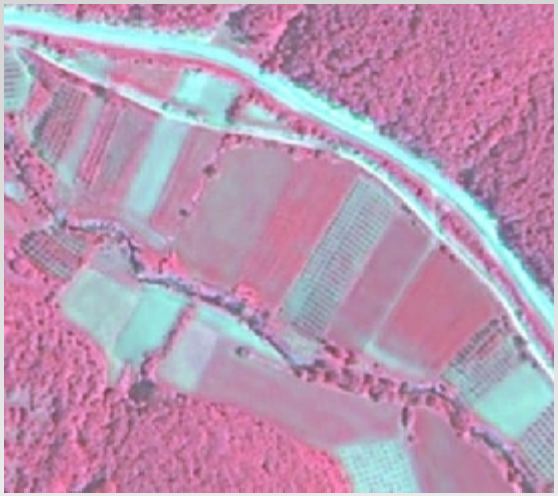

3rd December Salinity Estimation Map
706000
709000
712000
715000
718000
4069000
4066000
4063000
4060000
4057000
Settlement
Main Roads
Irrigation Chanel
Lagoon
EC mmohs/cm
High : 12
Low : 0
N
W
E
S
0 0.5 1 2 3 4 5
Km

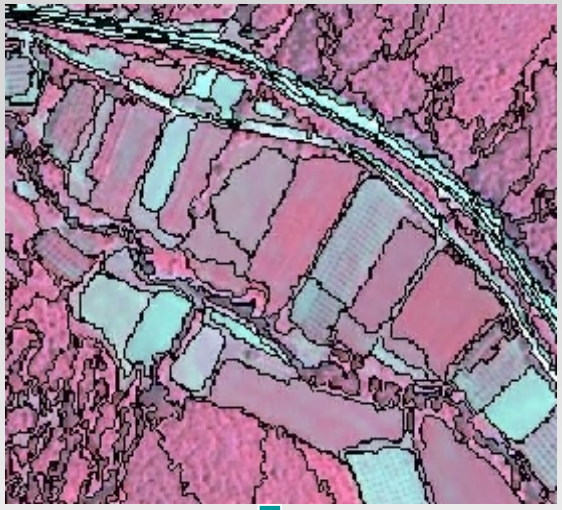
2. Lower Seyhan Plain (LSP)

- ***Salinity***
- ***Mapping & Monitoring Agricultural Land Use Pattern***
- ***Crop productivity***
- ***Land use modelling***

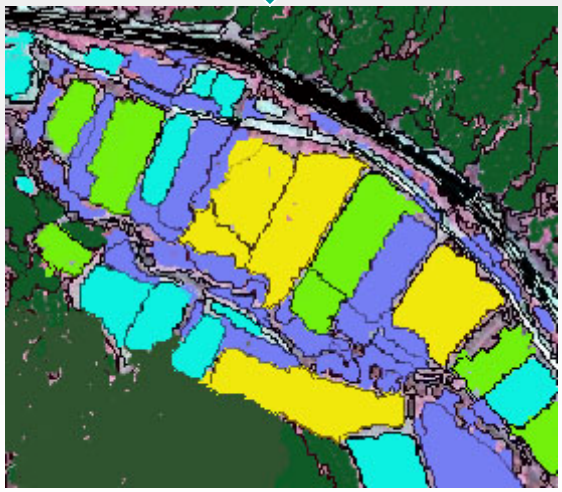
Mapping & Monitoring Agricultural Land Use Pattern

OBJECT BASED CLASSIFICATION





GROUNDTRUTH



1) Pre_processing

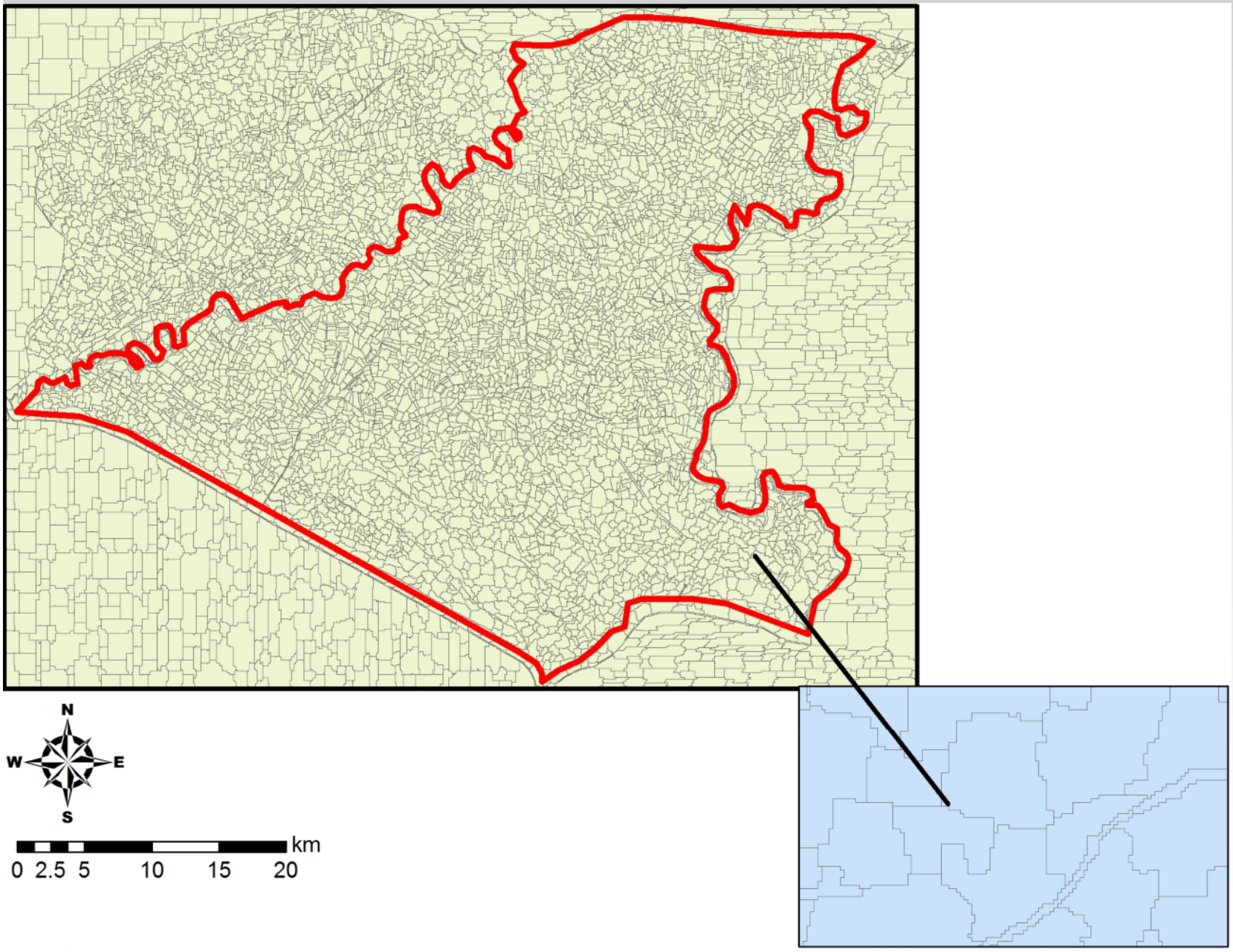
Rectification

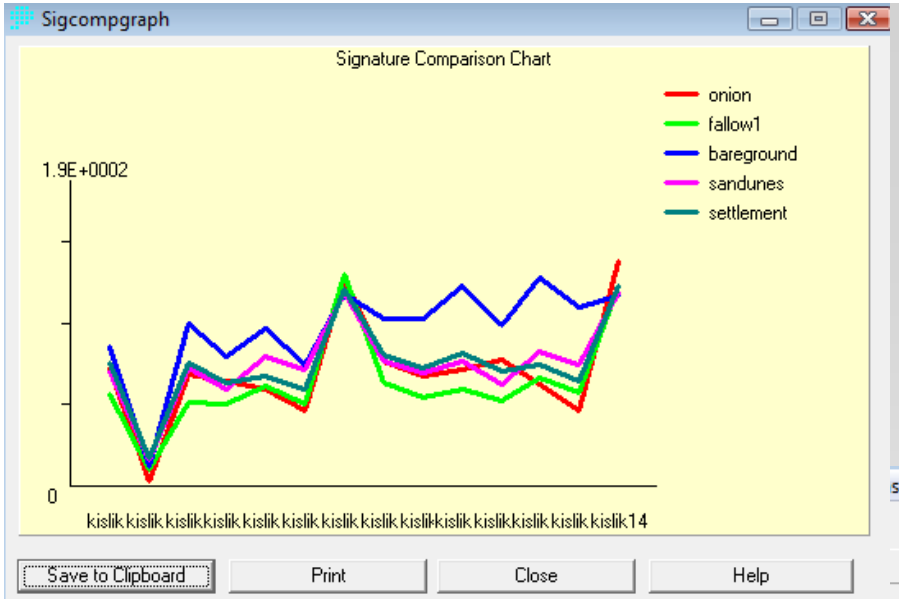
Atmospheric correction

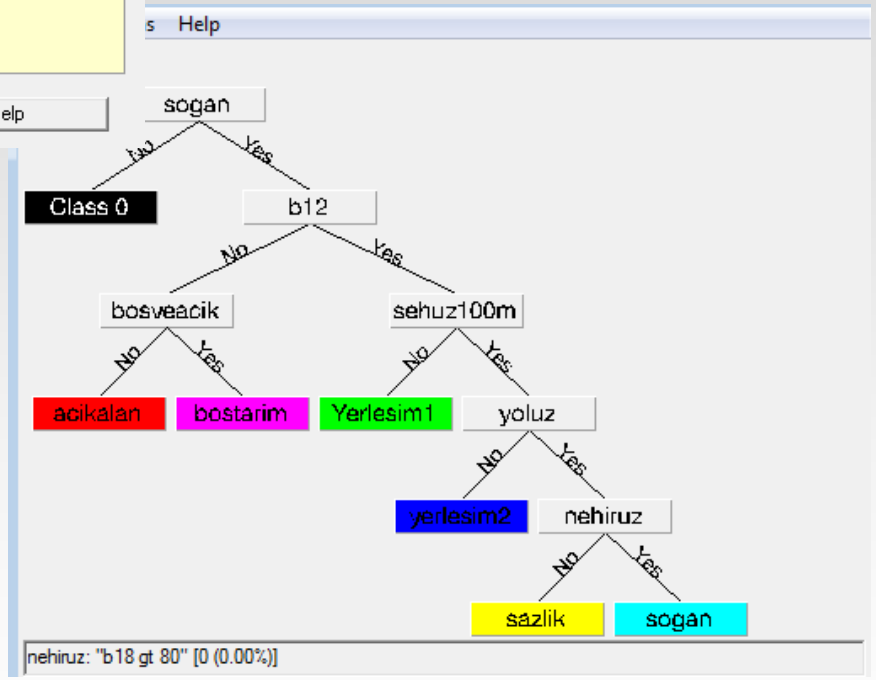
Radiometric normalization

REMOTELY SENSED DATA

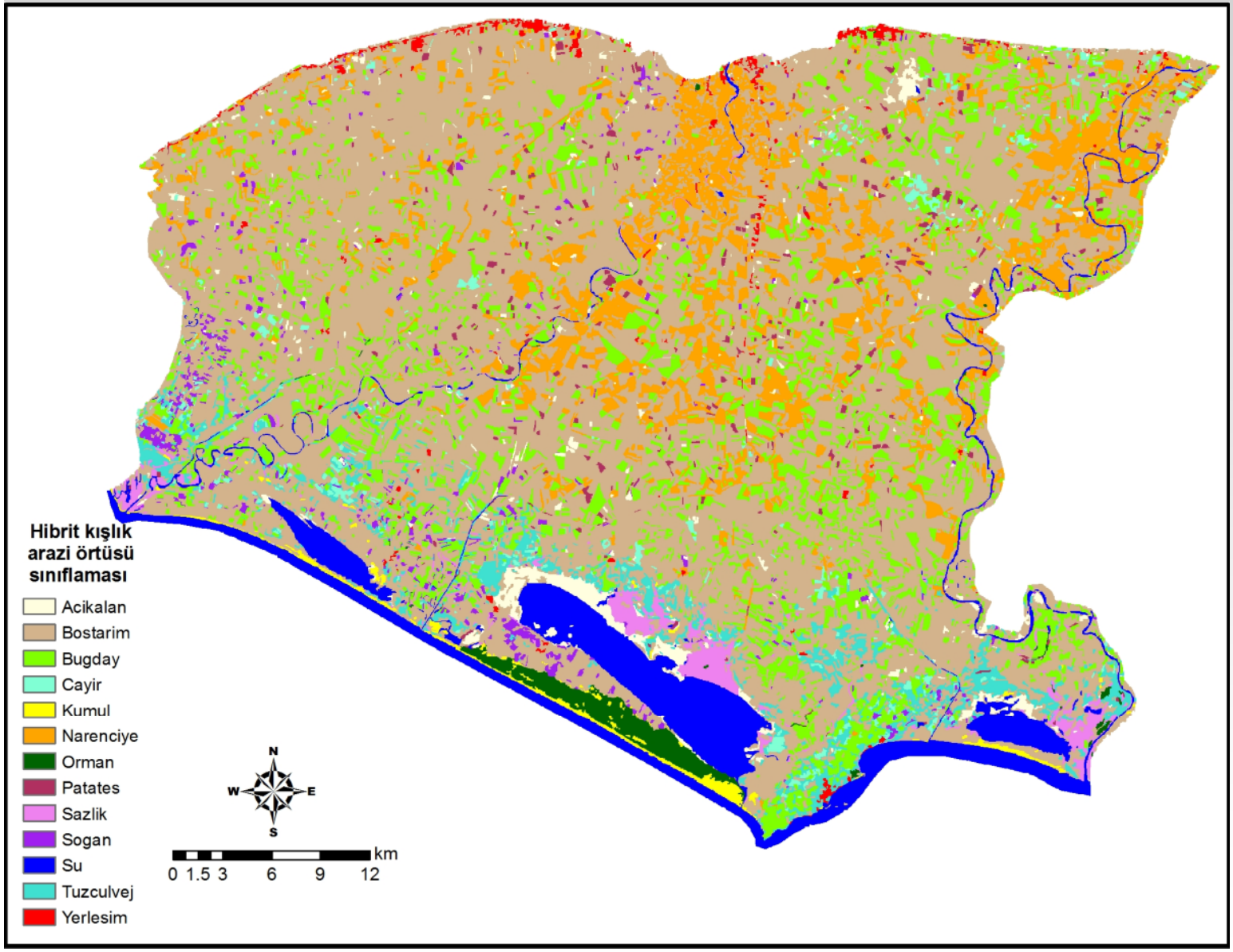
- Landsat TM/ETM
- SPOT (Pan and MS)
- ASTER
- ALOS AVNIR
- Aerial photos
- Municipality maps

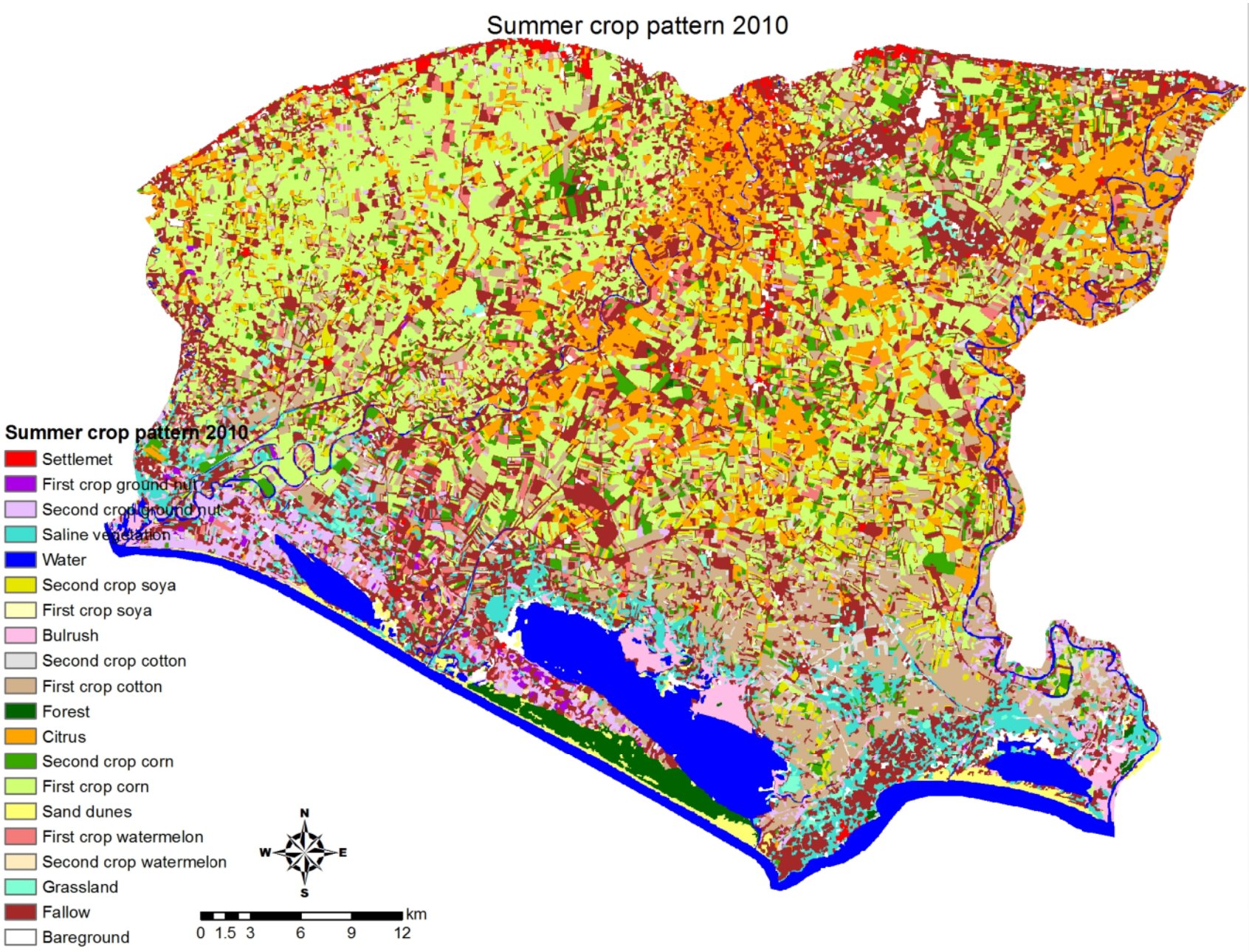

N
W
E
S
km
0 2.5 5 10 15 20


Sigcompgraph
Signature Comparison Chart
onion
fallow1
bareground
sandunes
settlement
1.9E+0002
0
kislik kislik kislik kislik kislik kislik kislik kislik kislik kislik kislik kislik kislik kislik kislik14
Save to Clipboard
Print
Close
Help


s Help
sogan
No
Yes
Class 0
b12
No
Yes
bosveacik
sehuz100m
No
Yes
No
Yes
acikalan
bostarim
Yerlesim1
yoluz
No
Yes
yerlesim2
nehiruz
No
Yes
sazlik
sogan
nehiruz: "b18 gt 80" [0 (0.00%)]

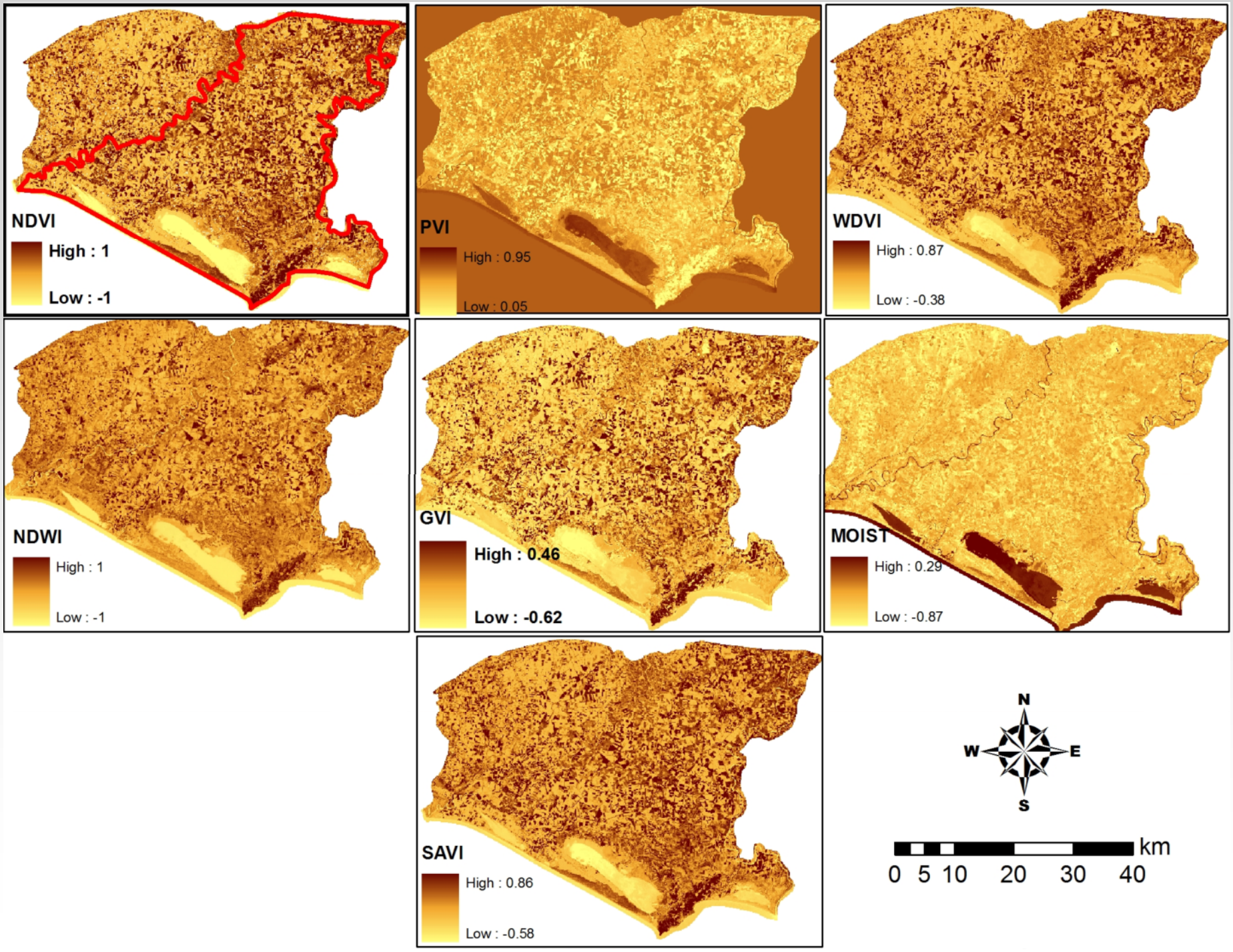
Mapping & Monitoring Agricultural Land Use Pattern




Summer crop pattern 2010
Summer crop pattern 2010
Settlemet
First crop ground nut
Second crop ground nut
Saline vegetation
Water
Second crop soya
First crop soya
Bulrush
Second crop cotton
First crop cotton
Forest
Citrus
Second crop corn
First crop corn
Sand dunes
First crop watermelon
Second crop watermelon
Grassland
Fallow
Bareground
N
W
E
S
km
0 1.5 3 6 9 12

2. Lower Seyhan Plain (LSP)

- Salinity
- Mapping & Monitoring Agricultural Land Use Pattern
- Crop productivity
- Land use modelling


NDVI
High : 1
Low : -1
PVI
High : 0.95
Low : 0.05
WDVI
High : 0.87
Low : -0.38
NDWI
High : 1
Low : -1
GVI
High : 0.46
Low : -0.62
MOIST
High : 0.29
Low : -0.87
SAVI
High : 0.86
Low : -0.58
N
W
E
S
km
0 5 10 20 30 40

Three statistical techniques for wheat productivity

- 1) Tümden gelim doğrusal regresyon modeli (BLR)
- 2) Üstsel regresyon modeli (POWER)
- 3) Kısmi en küçük kareler regresyon modeli (PLSR)

BLR

Verim = 166.277+30.128 * NDWI + 631.257 * NDVI + 903.214 * MOIST

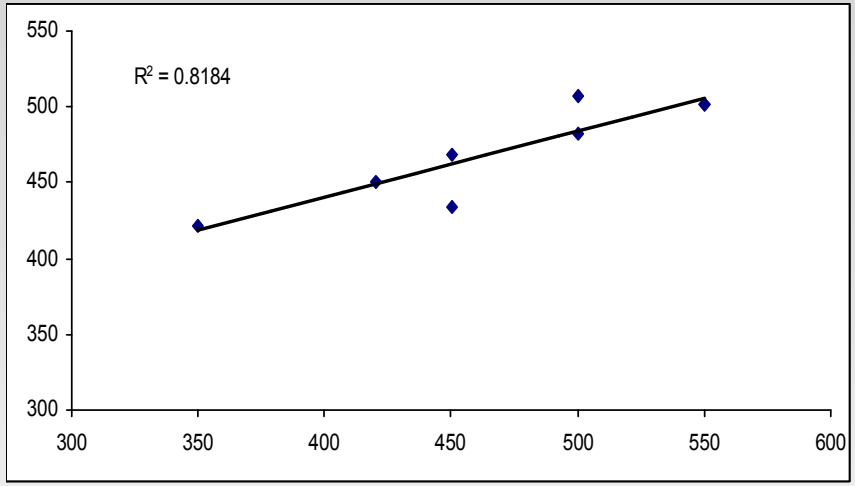
POWER

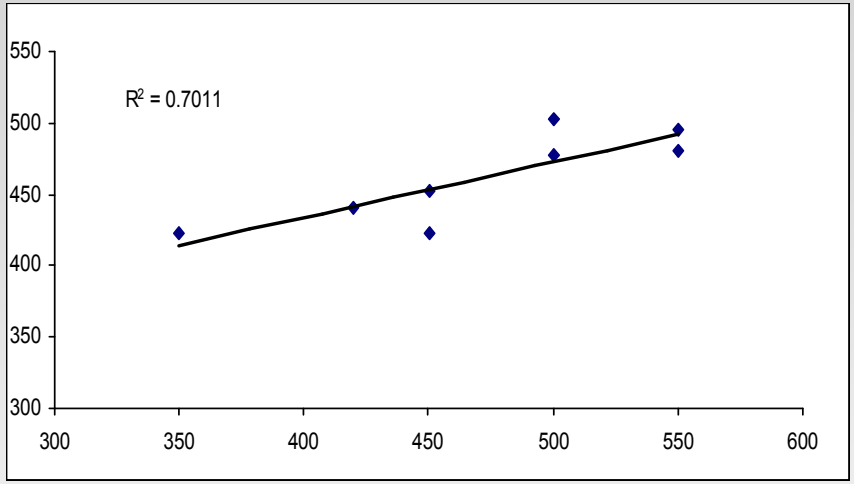
$$Verim = 731.59 * NDVI_{0.8785}$$

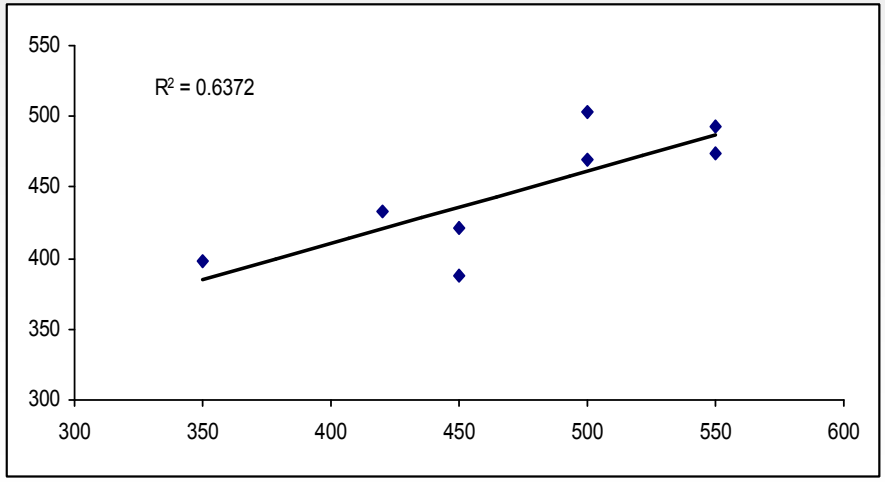
PLSR

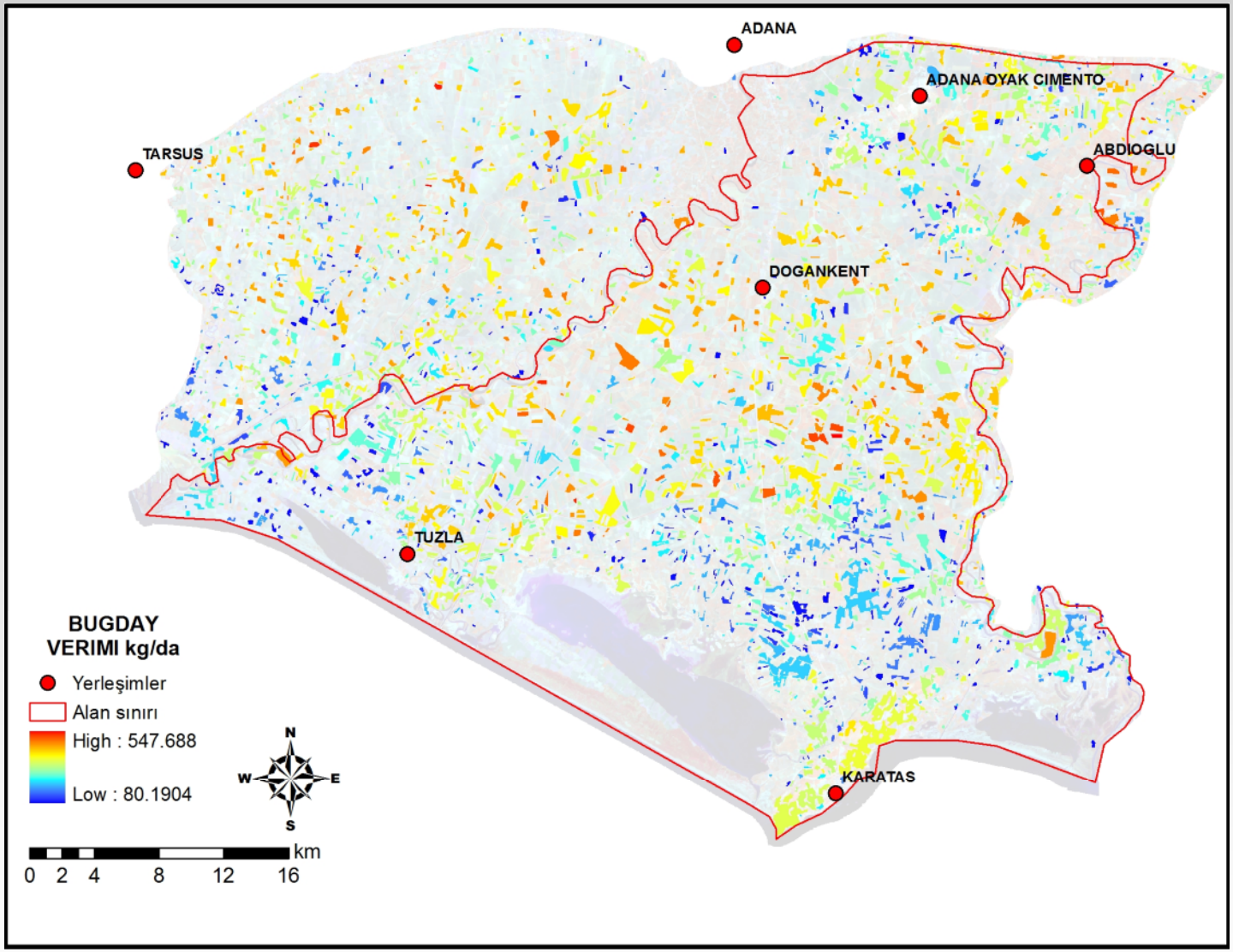
Verim = 300.389 * 101.197 * WDVI + 124.108 * SAVI – 135.467 * PVI + 54.139 * NDWI + 123.285 * NDVI + 395.968 * MOIST + 145.638 * GVI

validation


R² = 0.8184
550
500
450
400
350
300
300
350
400
450
500
550
600


R² = 0.7011
550
500
450
400
350
300
300
350
400
450
500
550
600

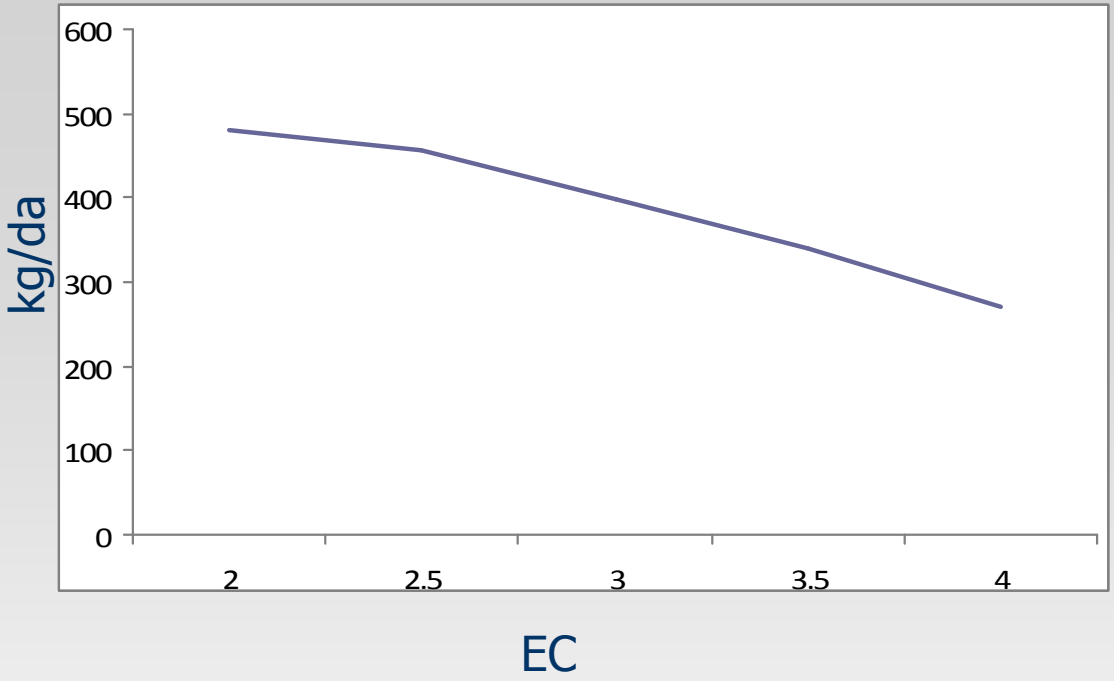

R² = 0.6372
550
500
450
400
350
300
300
350
400
450
500
550
600



- 2010

Çukurova wheat productivity: 116632.5 Tons

- Average 409kg/da
- Error %7.6'dır.


600
500
400
300
200
100
0
kg/da
2
2.5
3
3.5
4
EC

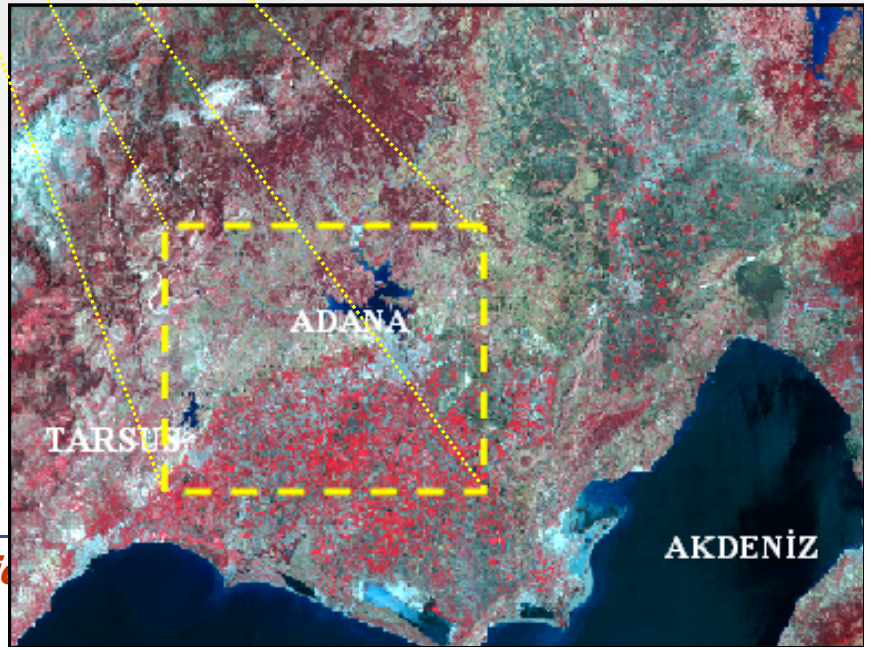
2. Lower Seyhan Plain (LSP)

- Salinity
- Mapping & Monitoring Agricultural Land Use Pattern
- Crop productivity
- Land use modelling

Land use modelling

STUDY SITE and DATA

- Landsat TM/ETM
- SPOT (Pan and MS)
- ALOS AVNIR
- Aerial photos
- Municipality maps

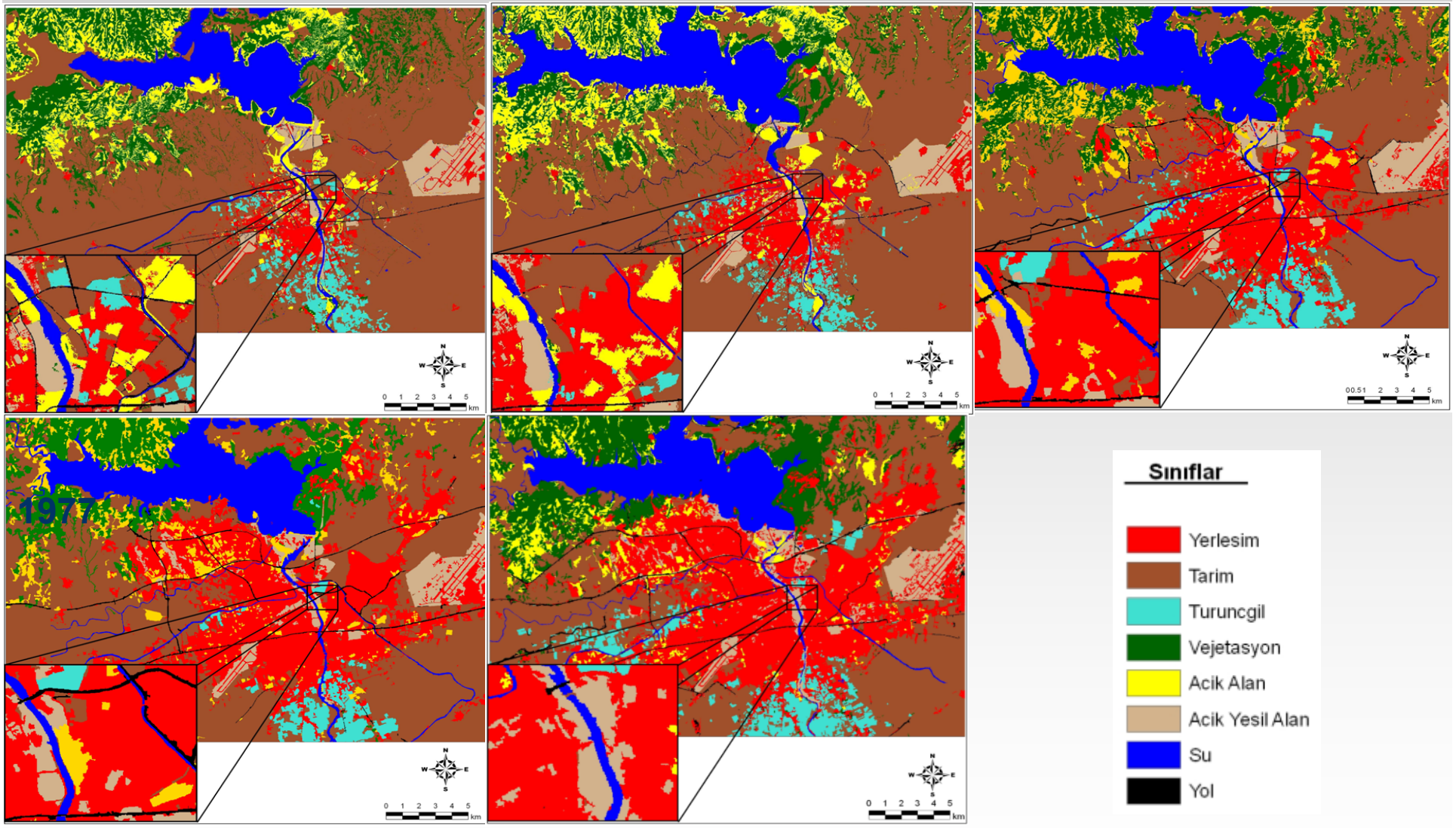


Change detection

1967

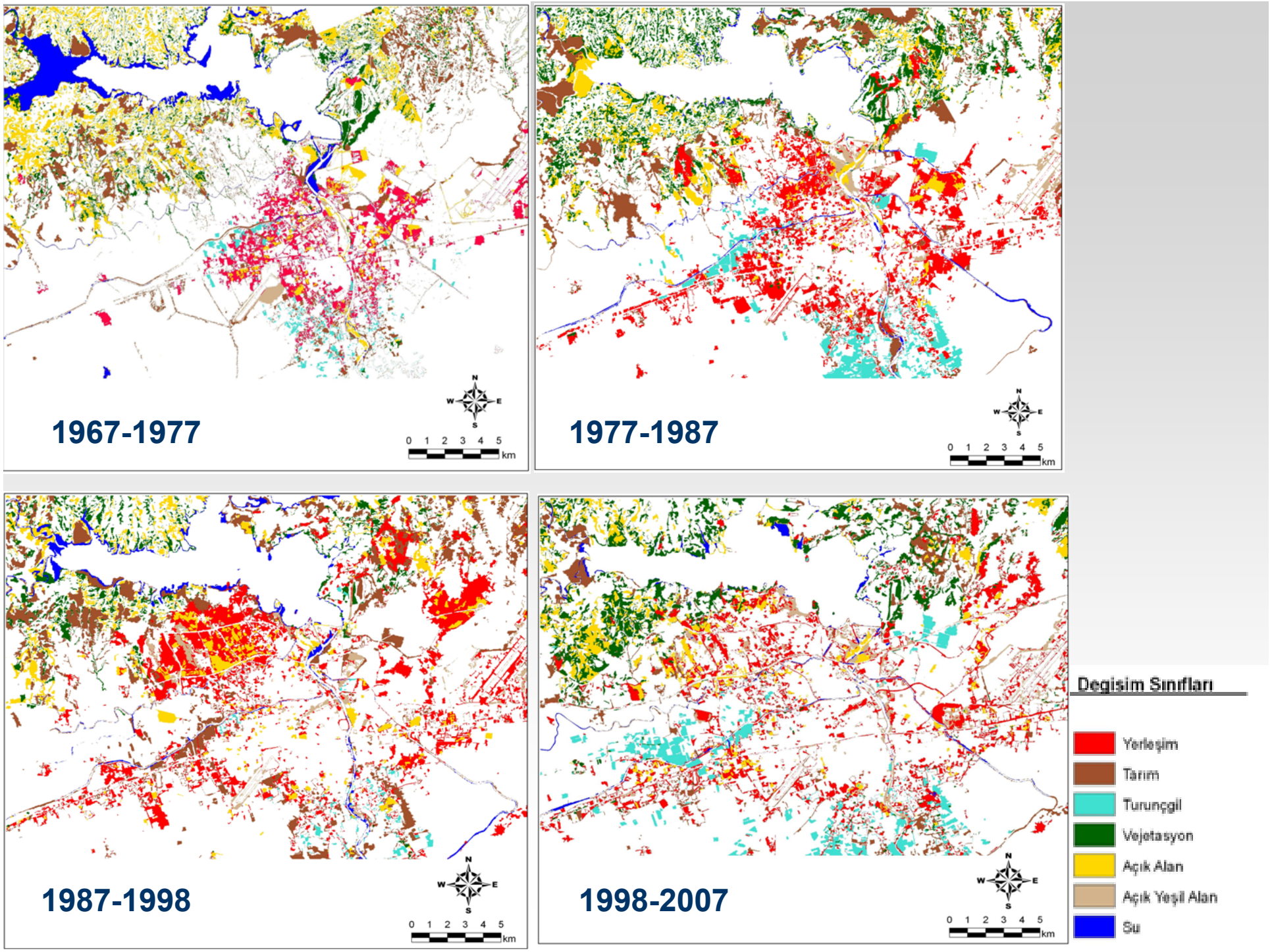
1977

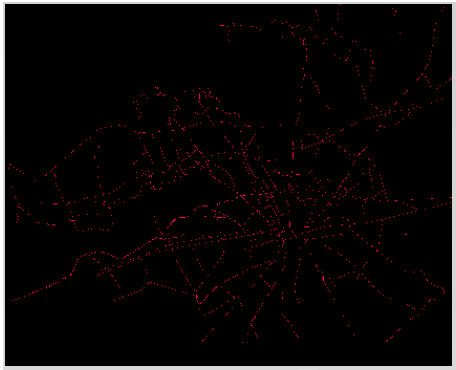
1987



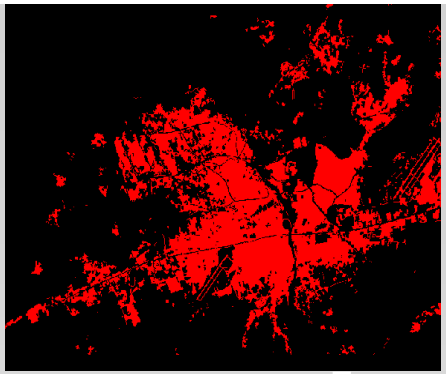
1998

2007

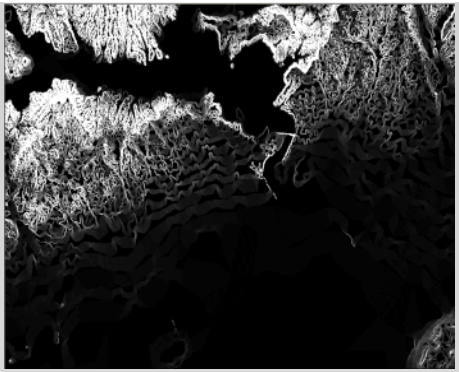

1967-1977
1977-1987
1987-1998
1998-2007
N
W
E
S
0 1 2 3 4 5
km
Degisim Sınıfları
Yerleşim
Tarım
Turunçgil
Vejetasyon
Açık Alan
Açık Yeşil Alan
Su



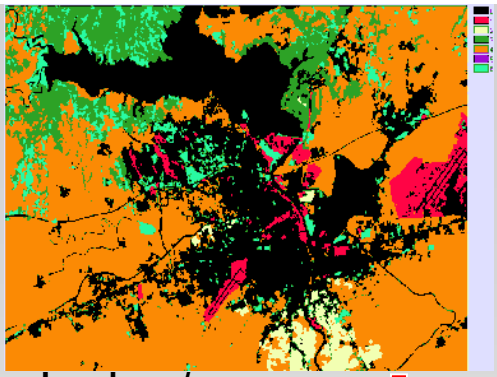
Road network



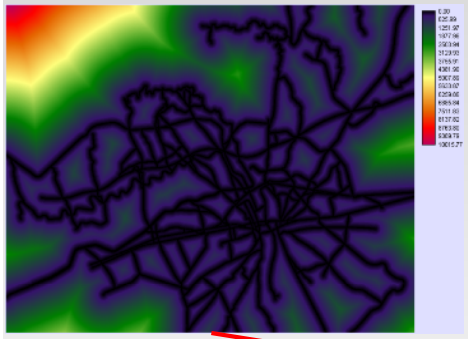
Urban



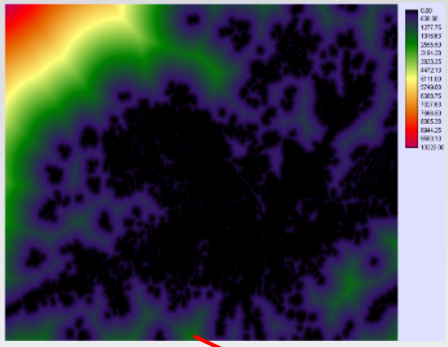
Slope



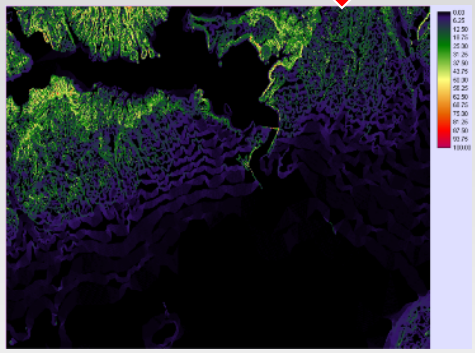
Land use/cover



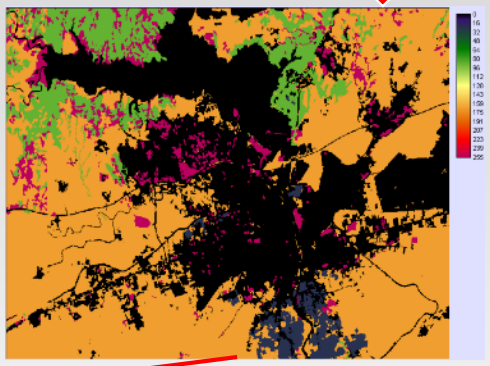
Road distance



Urban distance



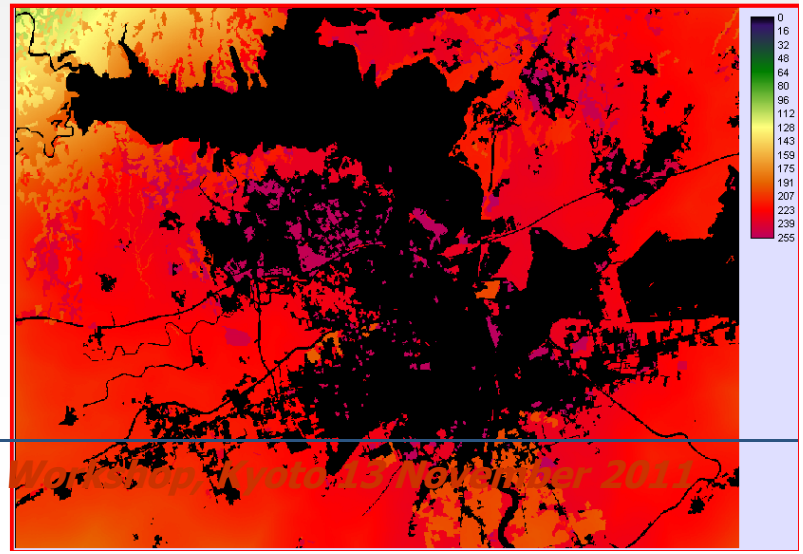
Slope

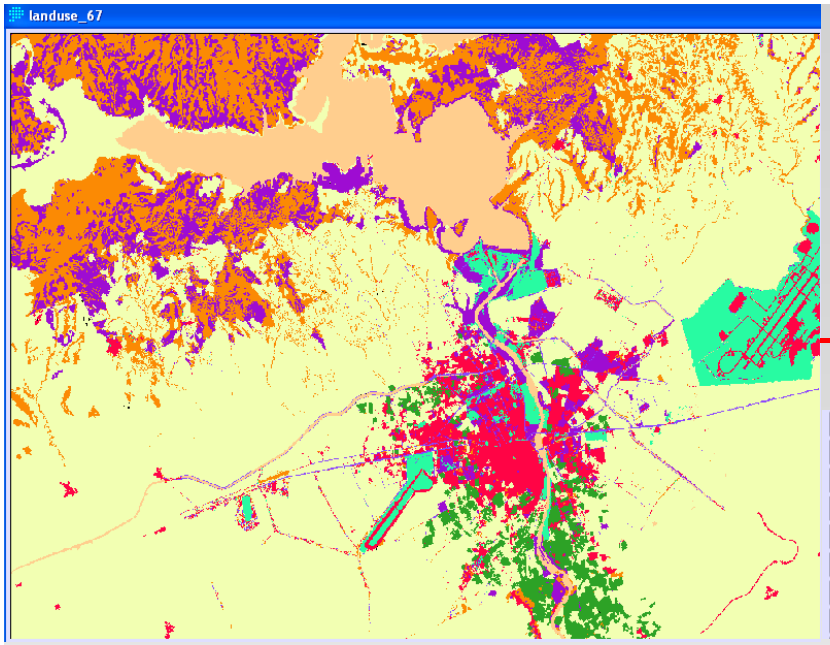


Scaled land use/cover

Factor name	Factor weight
land_fuzzy	0.6000
road_fuzzy	0.7000
slope_fuzzy	0.6000
urban_fuzzy	0.9000

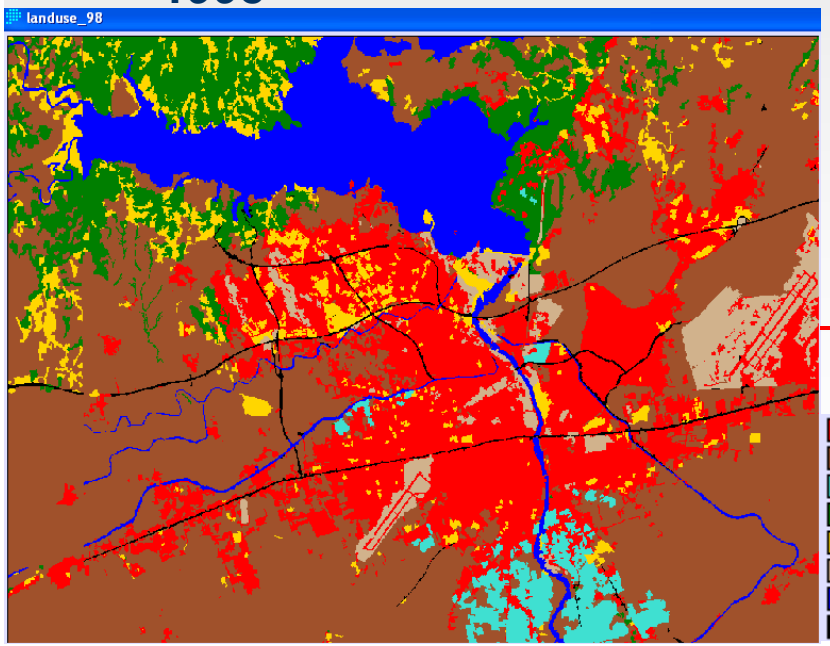
Suitability map





1967

1998



Class 1: Urban

Class 2: Agriculture

Class 3. Citrus

Class 4: Vegetation

Class 5: Bare ground

Class 6: Open green space

Class 7. Water

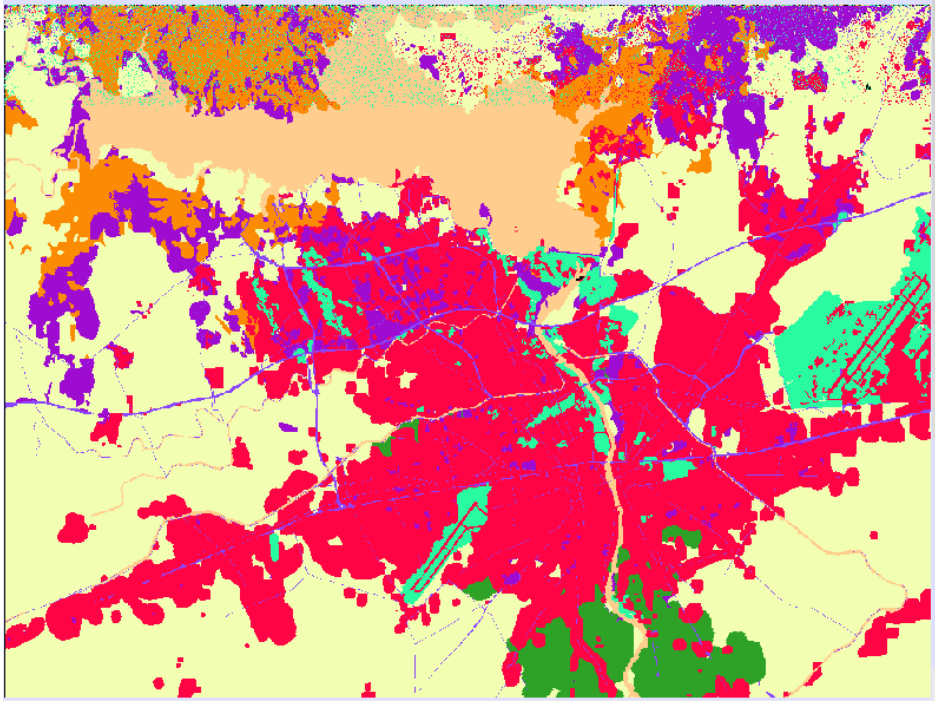
Class 8: Road

Probability matrix

	Cl. 1	Cl. 2	Cl. 3	Cl. 4
Class 1 :	1057366	54247	6187	0
Class 2 :	493455	2209687	66792	17029
Class 3 :	37371	10433	95947	0
Class 4 :	0	153071	0	301449
Class 5 :	23413	89252	0	119667
Class 6 :	43928	9337	1134	1058
Class 7 :	3825	29172	695	23896
Class 8 :	27082	9928	662	227

	Cl. 5	Cl. 6	Cl. 7	Cl. 8
Class 1 :				
Class 2 :	64249	116323	5310	41882
Class 3 :	205228	0	29027	50748
Class 4 :	6537	0	0	642
Class 5 :	99061	2274	534	0
Class 6 :	72425	9527	31430	2756
Class 7 :	8356	171112	0	562
Class 8 :	30046	9422	531445	7955
	1423	3605	4824	21007

Projected Land Cover

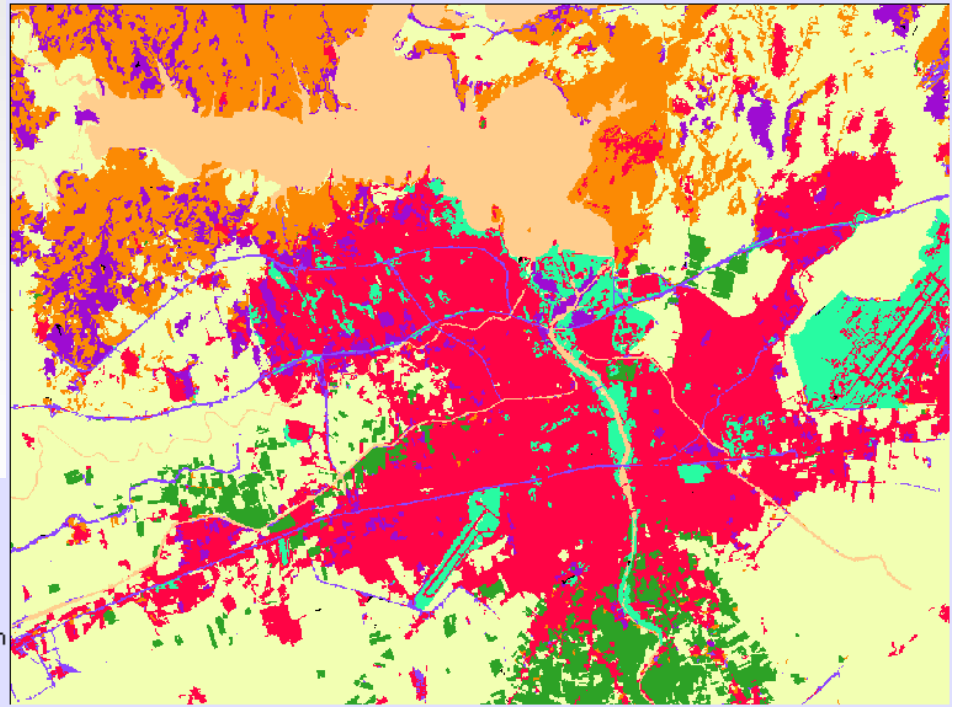


Category	Hectares	Legend
0	66.3300000	no data
1	18612.2600000	yerlesim
2	24998.4700000	tarim
3	1877.7400000	turuncgil
4	4013.7600000	vejetasyon
5	4895.1000000	acikalan
6	2751.1300000	acikyesilalan
7	5859.3400000	su
8	1158.5700000	yol

yerlesim
tarim
turuncgil
vejetasyon
acikalan
acikyesilalan
su
yol

Actual land use/cover (2007)

landuse_07

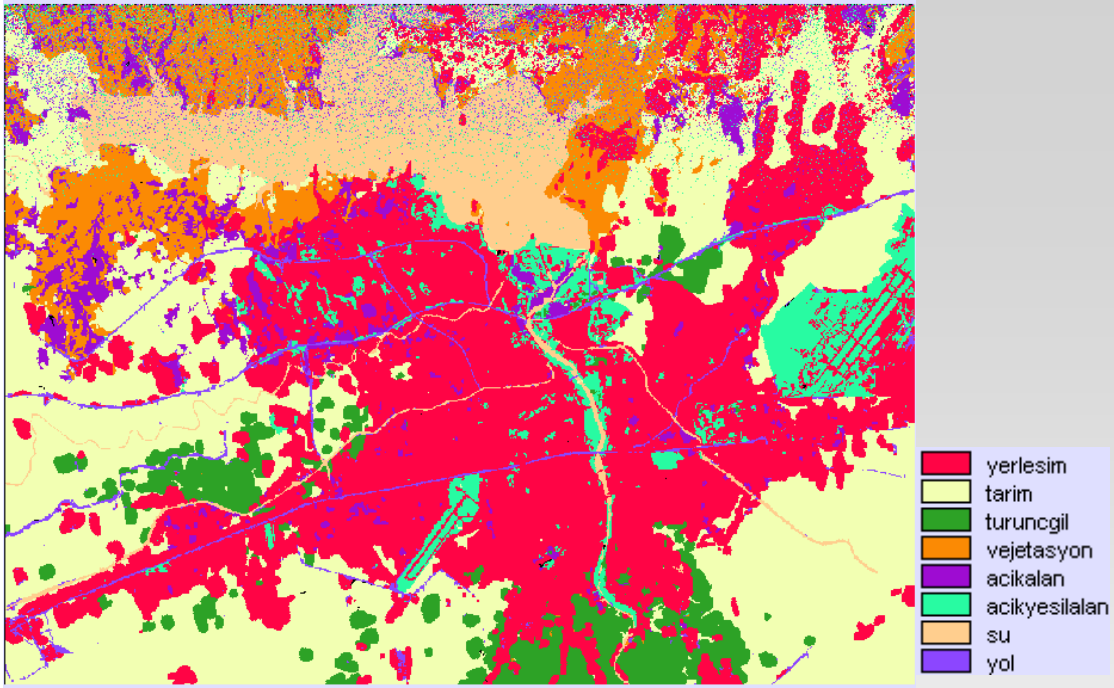


Modelled land use/cover (2007)

Category	Hectares	Legend
0	62.7300000	no data
1	18045.3200000	yerlesim
2	25405.8300000	tarim
3	1713.6800000	turuncgil
4	3910.3000000	vejetasyon
5	4735.5000000	acikalan
6	2981.0900000	acikyesilalan
7	6136.4300000	su
8	1241.8200000	yol

yerlesim
tarim
turuncgil
vejetasyon
acikalan
acikyesilalan
su
yol

Projected Land Cover

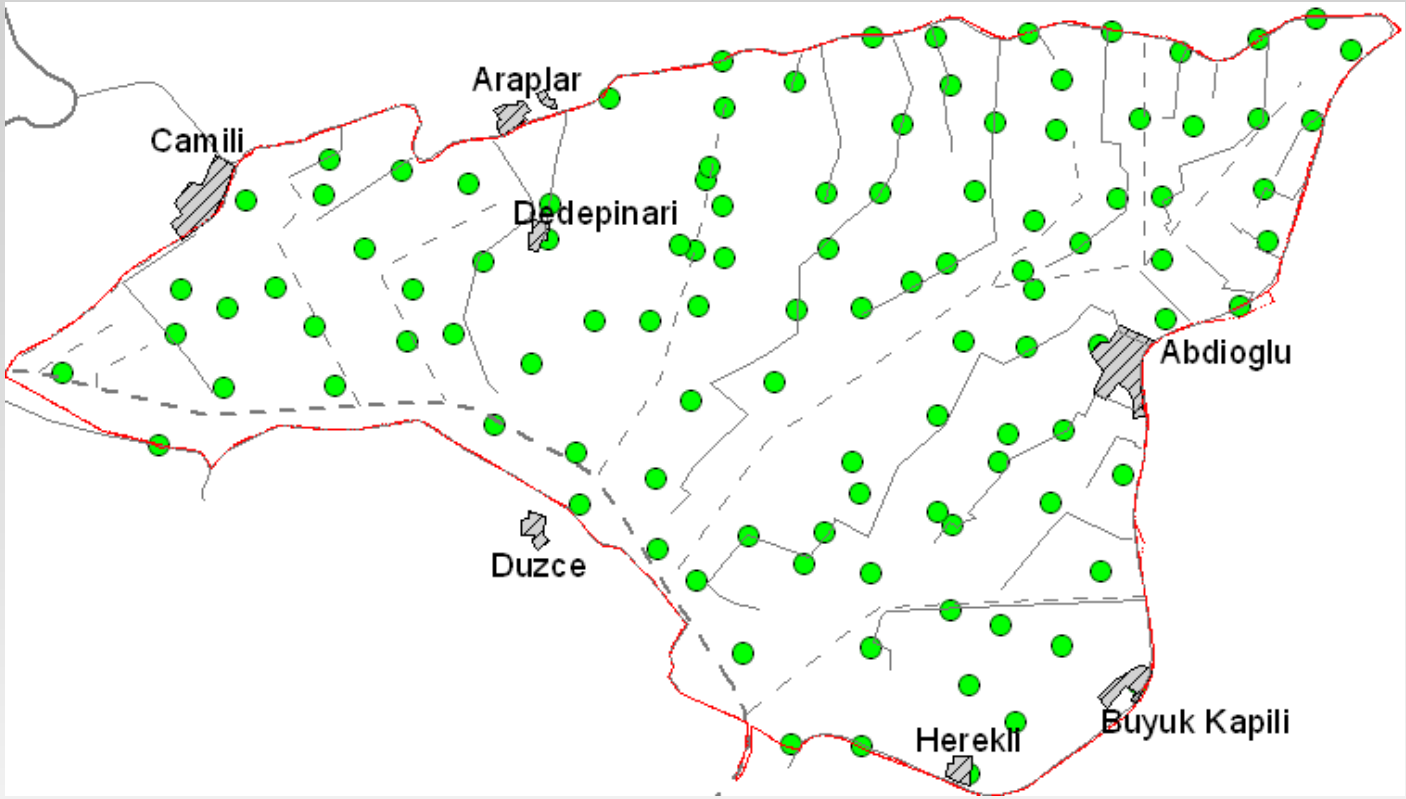


Modelled land use/cover (2023)

Category	Hectares	Legend
0	77.8000000	no data
1	21797.8200000	yerlesim
2	19254.8400000	tarim
3	3400.8900000	turuncgil
4	5550.2200000	vejetasyon
5	3064.6300000	acikalan
6	3733.3300000	acikyesilalan
7	5554.5400000	su
8	1798.6300000	yol

3. Akarsu Irrigation District

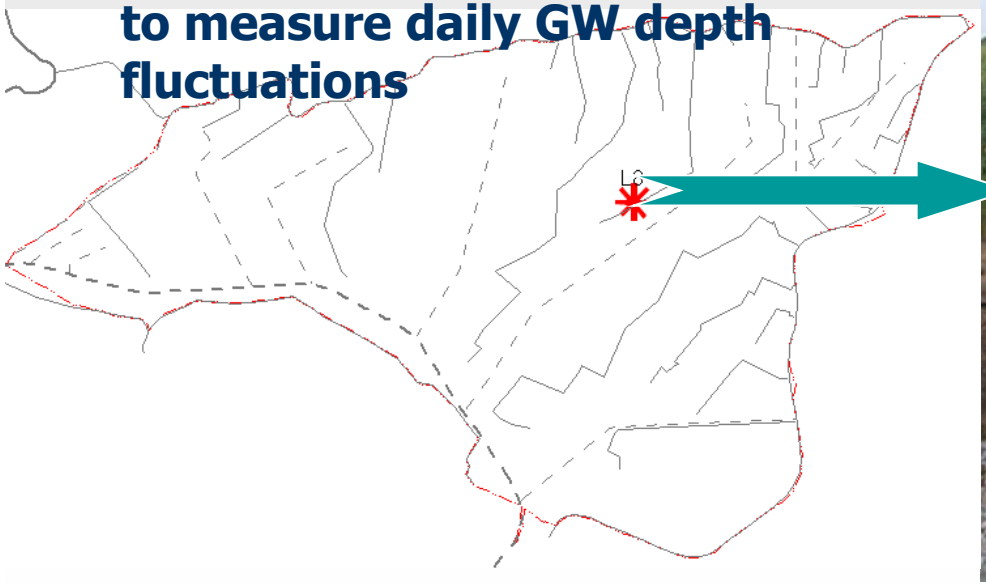
- Field measurements for water budget & quality (EC)
- irrigation return flow measurements
- Socio-economic structure

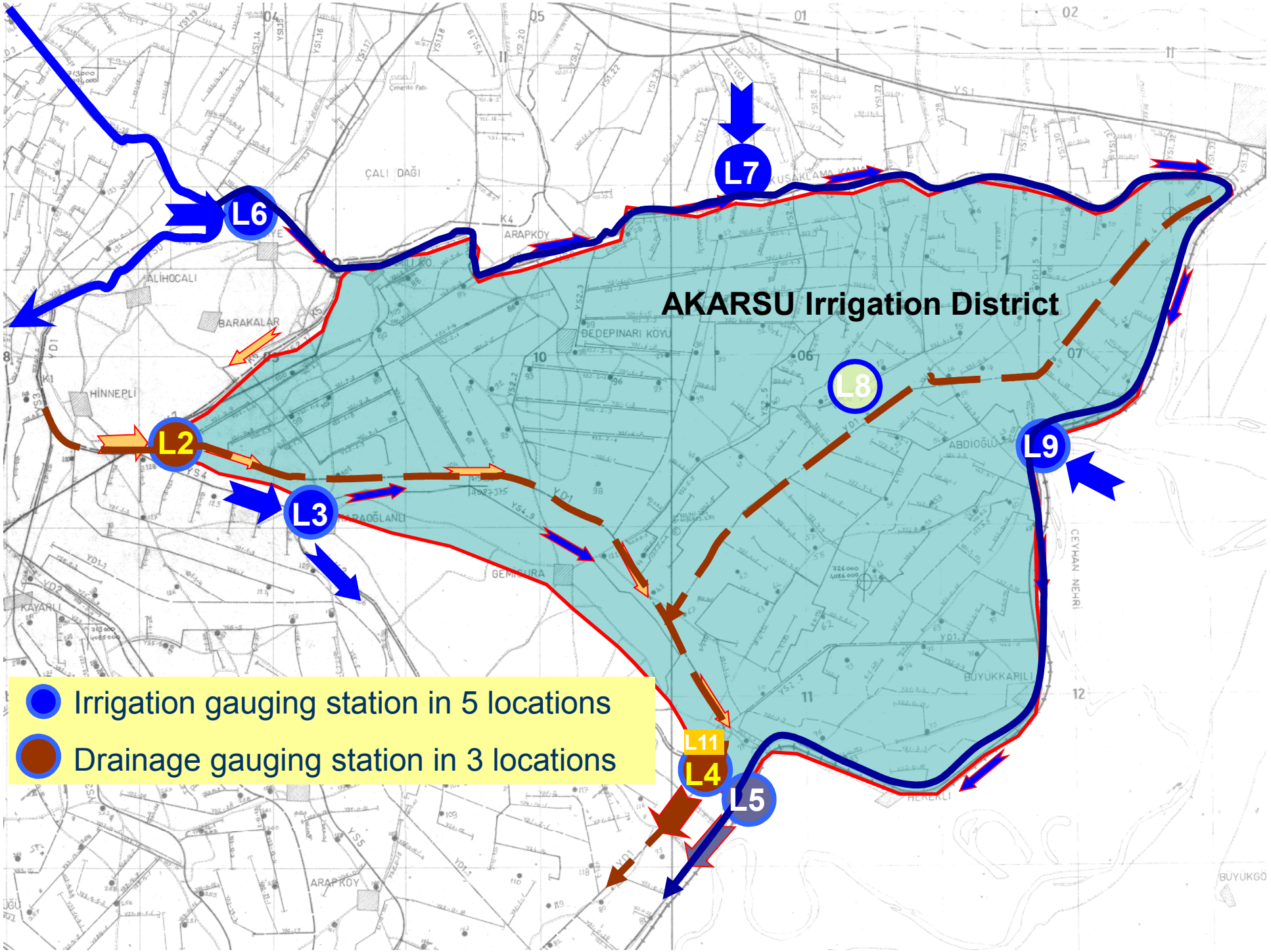


Spatial distribution of GW observation wells : 108

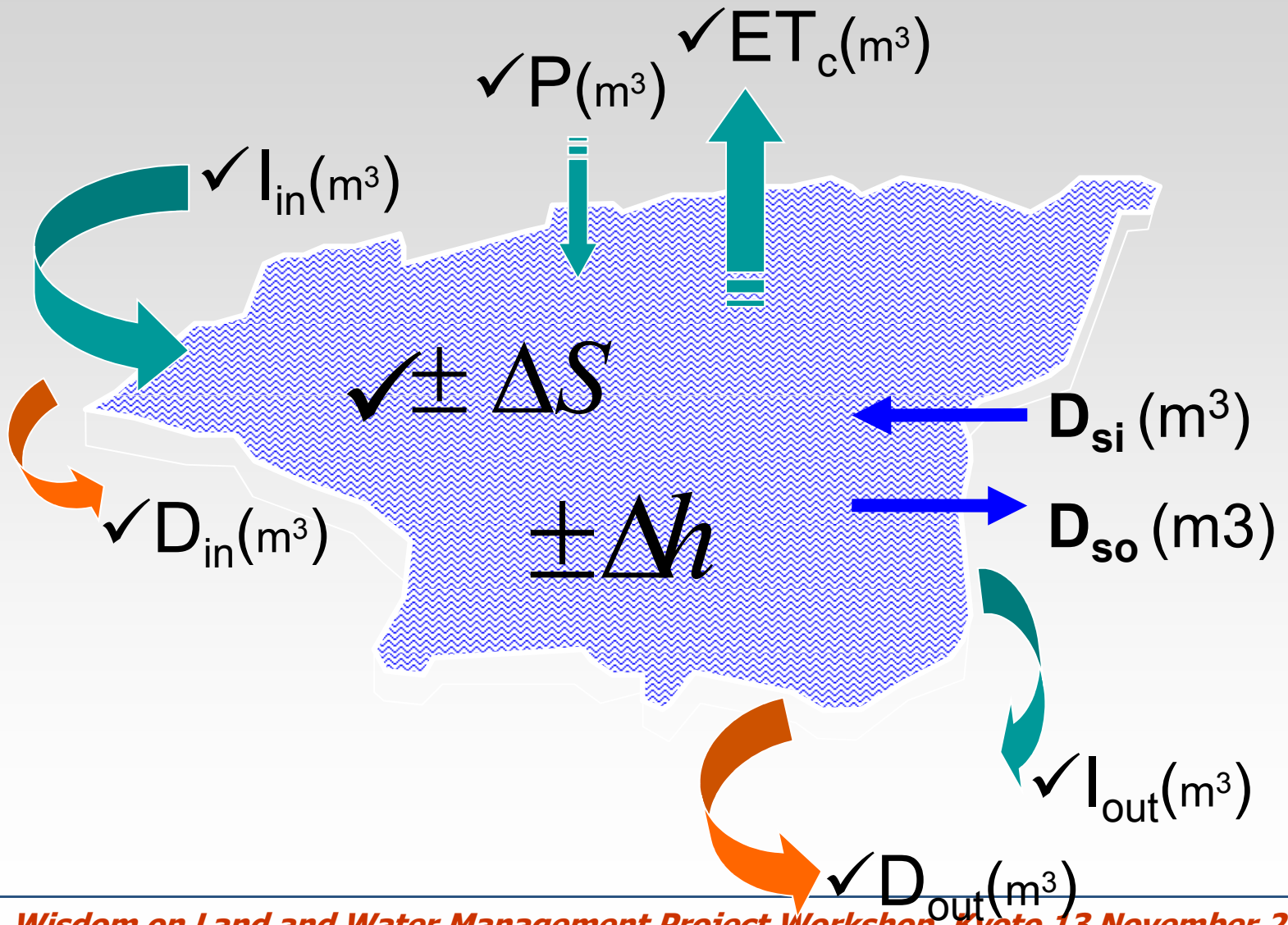
- Up to 3 m depth from soil surface to well bottom

An automatic water level recorder
was installed on one of the GW well
to measure daily GW depth fluctuations




AKARSU Irrigation District
L6
L7
L8
L9
L2
L3
L11
L4
L5
Irrigation gauging station in 5 locations
Drainage gauging station in 3 locations
ÇALI DAĞI
ARAPKÖY
ALİHOCALI
BARAKALAR
HİNNEPLİ
DEDEPINARI KÖYÜ
ABDIOĞLU
BÜYÜKKARILI
CEYHAN NEHRI

Assesments of water and salt balance terms



CONCLUSION

Challenge of *Wisdom on Land and Water Management – Designing Local Framework of Integrated Resources Management Use*
Project is*:*
Transferring these pile of information into management through Decision Support Systems