TEMPORAL AND SPATIAL DISTRIBUTION OF NITRATE LEACHING IN MEDITERRANEAN IRRIGATED AGRICULTURAL ECOSYSTEMS

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Outline

- Background
- Research Area : A case study
- Findings / Implications

Background

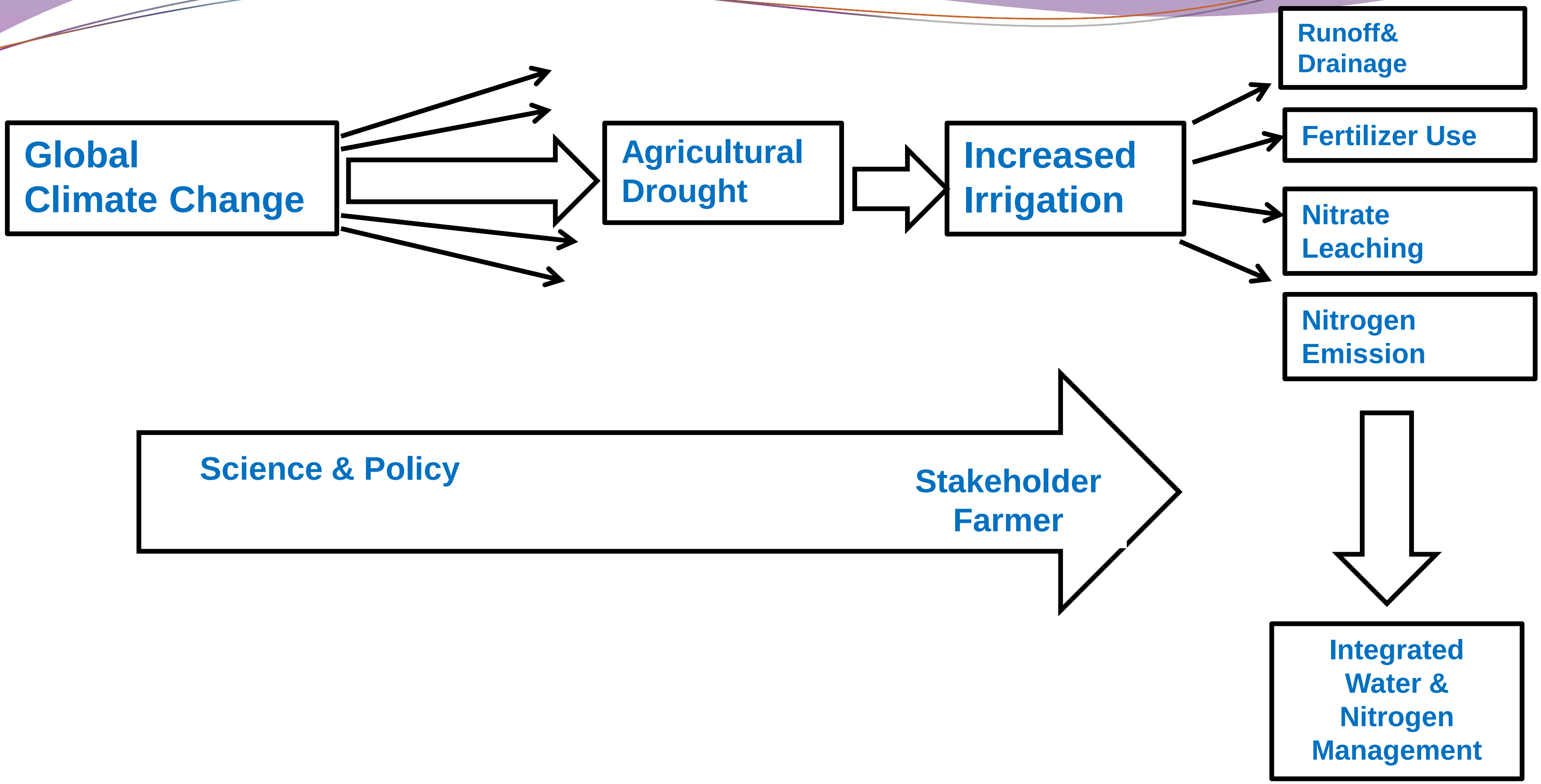
- **Limited research on:**
  - **water pollution in an irrigated area**
  - **nitrate and salt dynamics in the soil profile**
  - **nitrate and salt budget**
  - **modelling**
  - **regional impacts**

- **The related projects: 2006 - present**
  - **Five different projects with Spain, Germany, Japan and Slovenia**

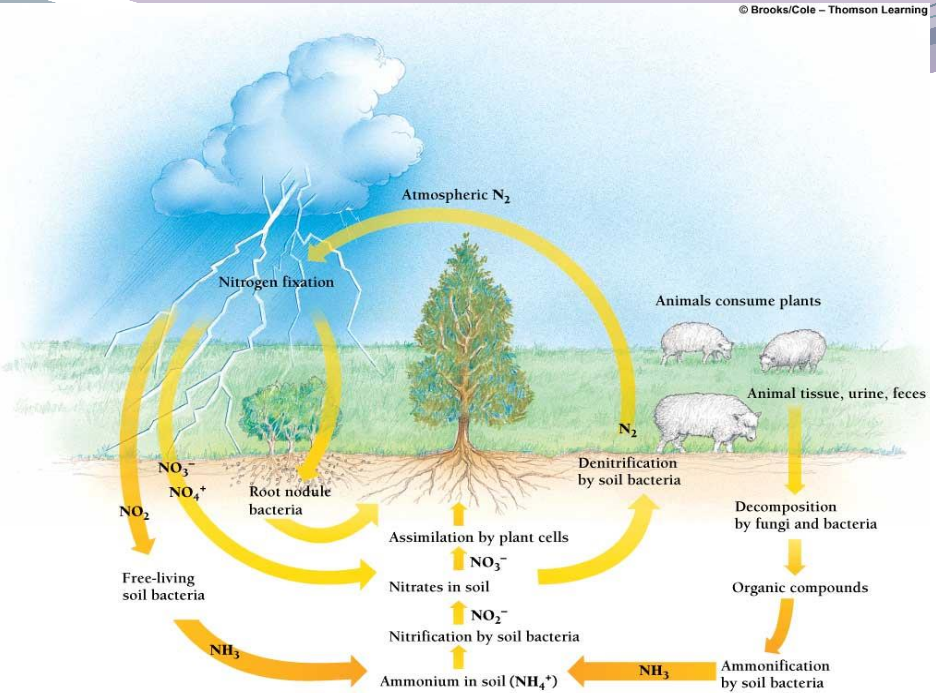
- **Mediterranean countries, including Turkey, among the other sub humid counties in the world are likely to be seriously affected by global climate change in the coming decades, with serious and prolonged drought conditions and consequent limitations on crop production.**

- **Irrigation, together with nitrogen fertilizers can induce two major environmental problems, i.e. nitrate leaching which influences the water quality, and denitrification loss as gas forms to the atmosphere, which is a major risk to global warming.**

- **Therefore, action needs to be taken to address those concerns. Integrated water and fertilizer management worldwide is one approach, involving an increasingly important role in terms of productivity of agricultural crops and sustainable use of water resources.**



Global Climate Change
Agricultural Drought
Increased Irrigation
Runoff& Drainage
Fertilizer Use
Nitrate Leaching
Nitrogen Emission
Science & Policy
Stakeholder Farmer
Integrated Water & Nitrogen Management



- **Nitrogen is:**

- **A plant nutrient**
  - **Biologically fixed for plants**
  - **Fertilizer constituent**
  - **Energy source for microorganisms**
  - **Water pollutant (groundwater, drainage, surface water, rivers, lagoons.... etc.)**
  - **Emitted to the atmosphere; air pollutant**
  - **A factor on global warming**
  - **Important for farmers’ economy**

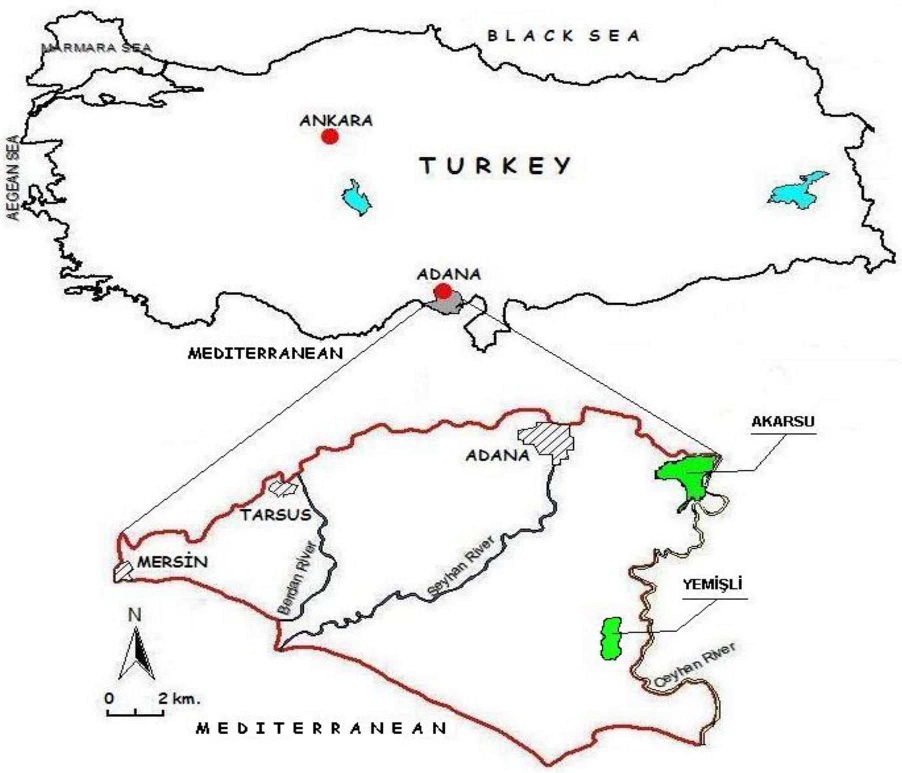
- Fertilizer practices (from the farmers survey)
  - DAP, 20-20-0, 15-15-15 at preplanting
  - Ammonium sulfate, ammonium nitrate, urea as side dressing
  - Fertigation
  - Foliar application

- **In European Countries, under the framework of “EU Directives”, NO_3 concentrations in water sources are determined for the critical/threshold levels.**

- **Until recently, nitrate pollution risks and mass-balance calculations in a broader agro-ecological medium (soil, plant, water and atmosphere), especially in water resources, were not considered in our region.**

- **Therefore, irrigation-induced NO_3 pollution in groundwater was assessed during the hydrological year of 2014 in Akarsu Irrigation District of southern Turkey.**

STUDY AREA : A case study



Lower SeyhanPlain,
Akarsu Irrigation District (9,495.00 ha)

Akarsu Irrigation District

Area
9,495 ha

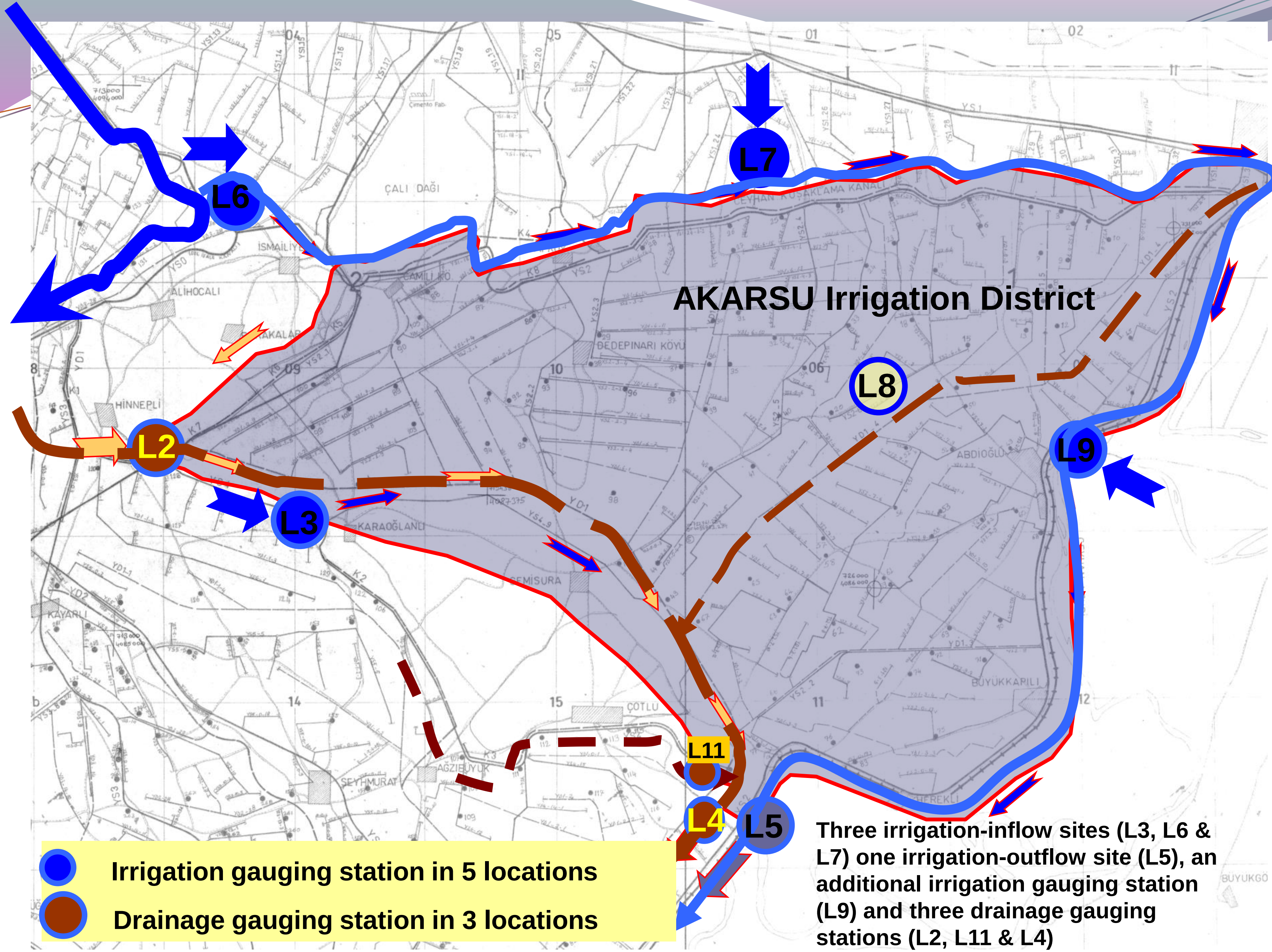
Climate
Mediterranean

Precipitation
650 mm

Average Temperature 18 ºC

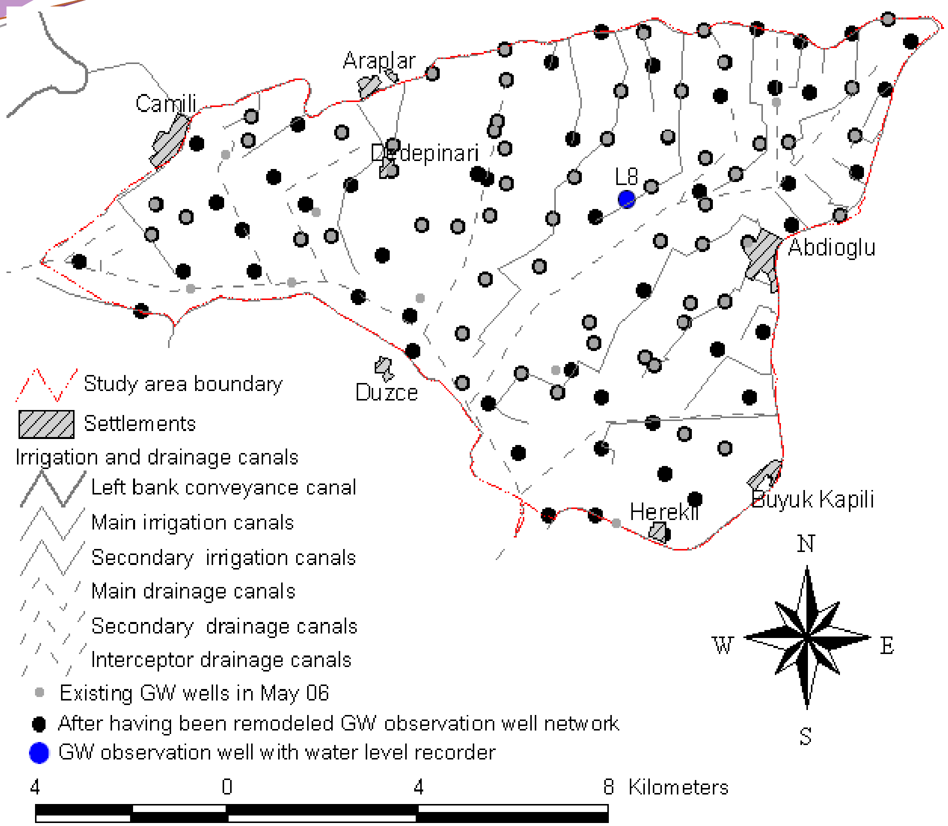
Water source
Seyhan Dam

Crops
Summer: Maize, Cotton
Winter: Wheat
Yearly: Citrus



- Irrigation gauging station in 5 locations
- Drainage gauging station in 3 locations

Three irrigation-inflow sites (L3, L6 & L7) one irrigation-outflow site (L5), an additional irrigation gauging station (L9) and three drainage gauging stations (L2, L11 & L4)

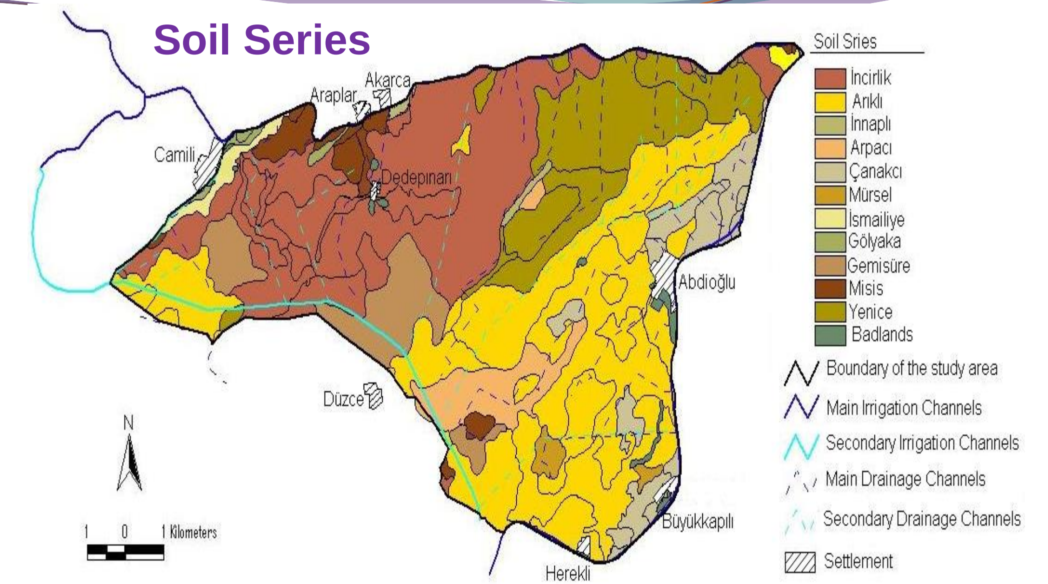


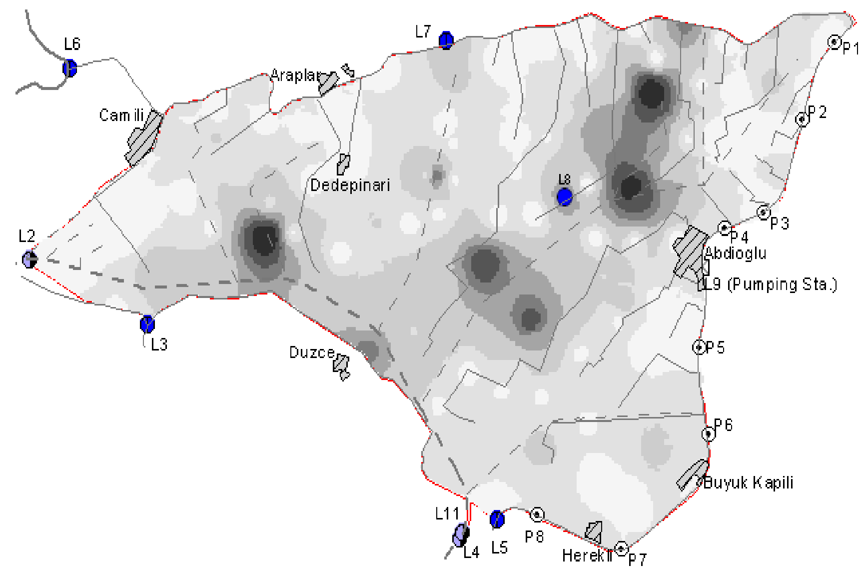
Groundwater sampling

January, March, July, Sept.

- **Soils are clay, high in calcium carbonate, high pH (>7.5) and low organic matter (< %1)**

- **There is soil mineral nitrogen**





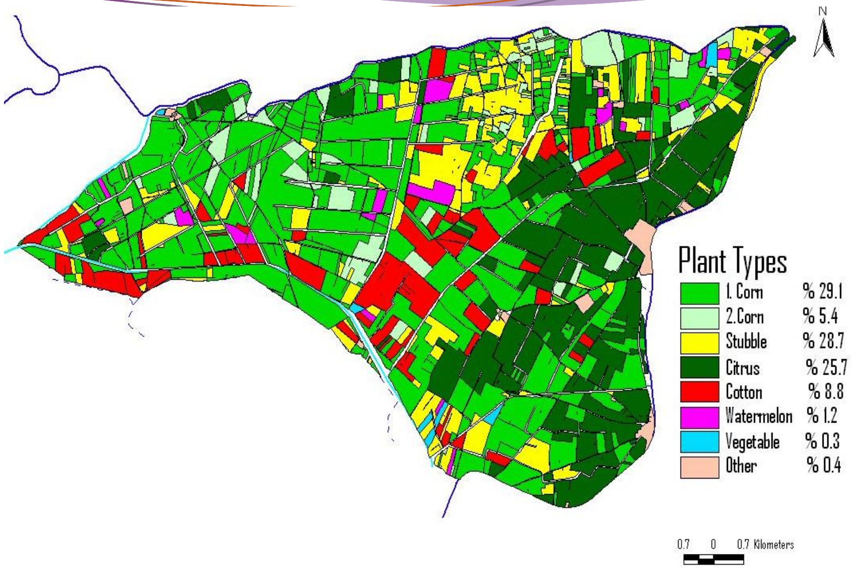
Land Use

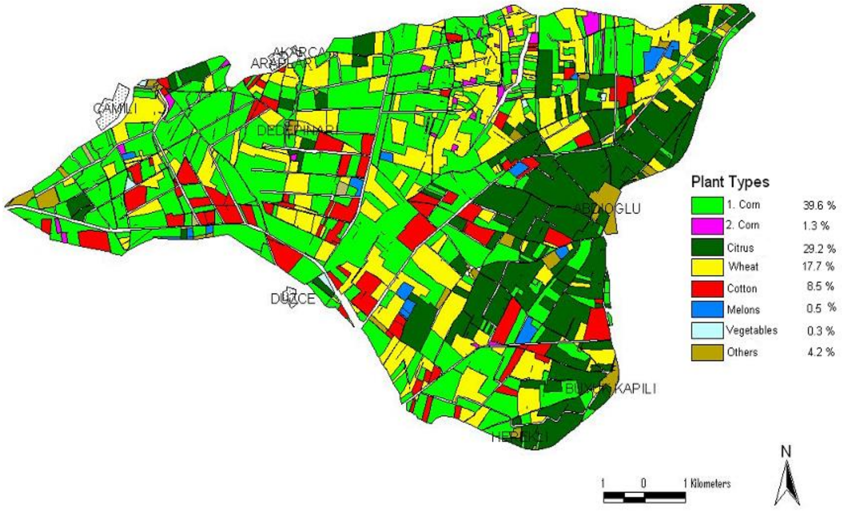
Crops	Area covering, %
Wheat	34.1 (3237.8 ha)
Citrus	25.8 (2449.7 ha)
1. corn	29.2 (2772.5 ha)
2. corn	5.4 (512.7 ha)
Cotton	8.9 (845.1 ha)
Melons	1.3 (123.4 ha)
Vegetables	0.3 (28.5 ha)
Others	0.4 (38.0 ha)

Surface / gravity irrigation

Sprinkler

Drip irrigation





RESULTS

Nitrate concentration distributions in 2014

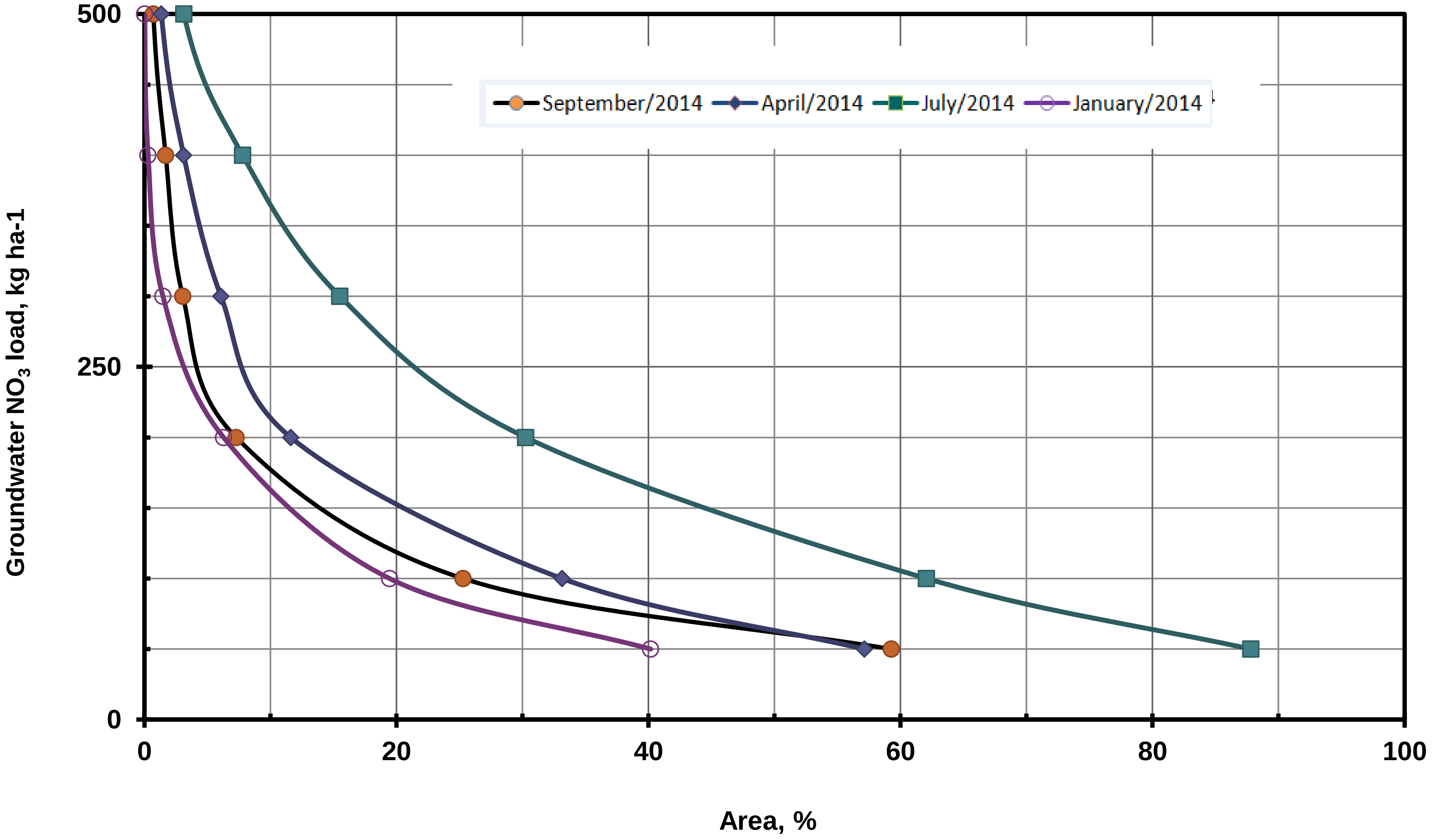
Time	Areal Mean ($mg\ L^{-1}$)	NO_3 concentration range ($mg\ L^{-1}$) <10	10-20	20-30	30-50	50<
		Areal coverage (%)				
January	12.4	61.5	20.2	8.5	8.5	1.3
April	22.9	22.3	40.4	18.7	11.8	6.8
July	29.5	21.2	34.1	18.9	17.0	8.7
September	13.4	50.7	32.7	8.7	5.6	2.3

- **Considerable seasonal effects on NO_3 levels in the groundwater.**

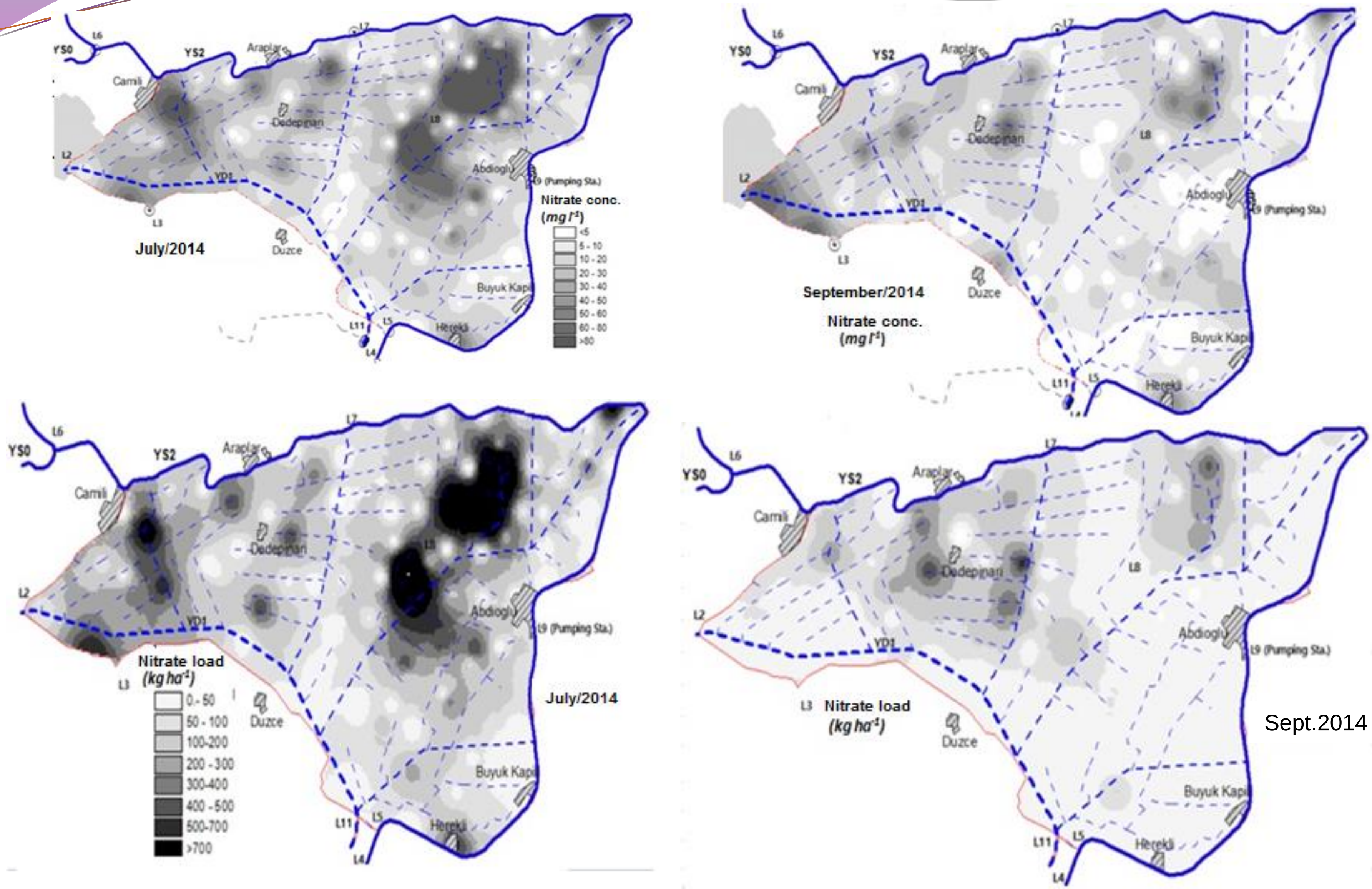
- **Consistently higher NO_3 values in spring (in wet season) and July (irrigation season).**

- **The main crop, wheat, is in the dormant-to-tillering stage in winter and early spring without any significant N uptake by the crop.**

- **Low nitrate concentration values September after crop harvest and in January.**


September/2014
April/2014
July/2014
January/2014
500
250
0
Groundwater NO3 load, kg ha-1
0
20
40
60
80
100
Area, %

Nitrate conc. and loads in July and Sept. 2014



Soil / Fertilization

Excess fertilizer use (average of 297 kg N / ha)

Soil mineral nitrogen accumulation

(70-388 kg Nmin/ha)

Crops	Nitrogen Fertilizer Rates (2014)
	kg N ha^{-1}
Wheat	265
1. corn	380
2. corn	360
Citrus	350
1. cotton	310
2. cotton	310
Melons	282
Vegetables	163
Vegetable greens	173
Legumes (soybean, peanut..)	160

Routine soil mineral nitrogen analysis, plant analysis, N use efficiency, integration with irrigation, modelling and senarios

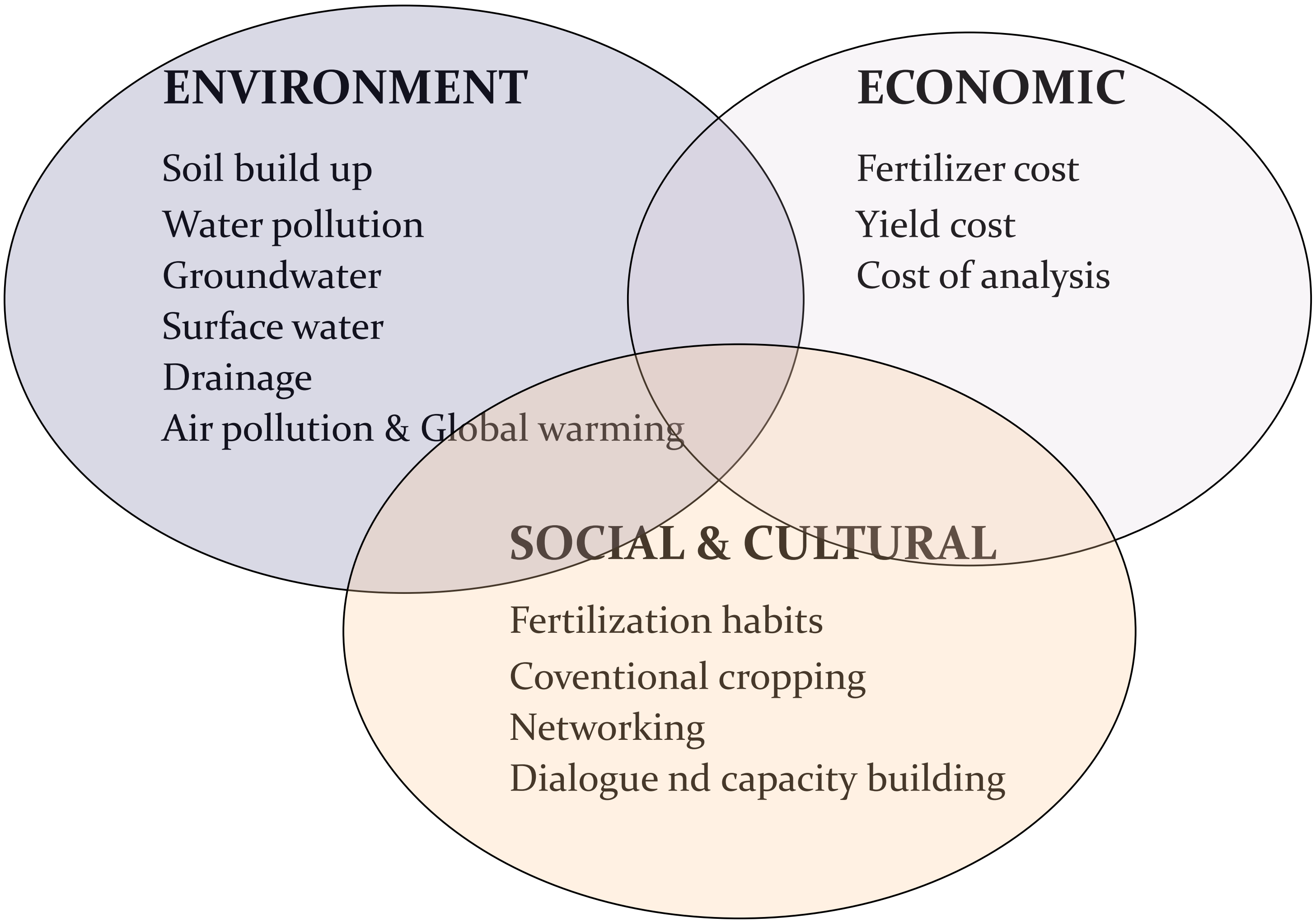
Farmer's awareness, dialogue, capacity building, demonstration

Previous status:

- Plot size – fertilization trials
- Limited district level research
- Limited demonstrations at the farmers' fields
- Limited monitoring research and data

What we have learned / needs:

- Implementation of research findings at farmers' level
- Interdisiplinary work (co-design and co-production)
- Discover the interests of stakeholders
- Better communication and networking with farmers


ENVIRONMENT
Soil build up
Water pollution
Groundwater
Surface water
Drainage
Air pollution & Global warming
ECONOMIC
Fertilizer cost
Yield cost
Cost of analysis
SOCIAL & CULTURAL
Fertilization habits
Coventional cropping
Networking
Dialogue nd capacity building

CONCLUSIONS

- Cropping pattern, irrigation water and fertilizer application practices have the main effect on water quality and quantity aspects in the irrigated areas.
- Nitrogen fertilizer rates could be optimized.
- Irrigation practices need to be updated.
- Farmers and experts involvement are important.
- Research findings need to be shared by the government officers, experts, stakeholders and local farmers to apply environmental, social and economical development of the region.

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