QUANTIFYING TEMPORAL CHANGES OF NITRATE LOADS IN INTENSIVELY USED AGRICULTURAL LANDSCAPES OF THE SEMIARID MEDITERRANEAN TURKEY

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OUTLINE

- Background
- Objectives
- A case study
- Findings
- Conclusions & Recommendations
- Acknowledgement

BACKGROUND

- Irrigation ***is necessary for sustainability of agricultural production and crop diversification*** in the arid and semi-arid areas of the world, including the Mediterranean region.
- **Therefore, irrigated agriculture produces about 40% of all food and fibre on about 16% of all cropped land.**
- **As such, irrigated agriculture is a productive user of resources.**

BACKGROUND (CONT.)

- **HOWEVER, many irrigation projects use much more water than consumed by the crops grown in the area.**

BACKGROUND (CONT.)

The **non-consumed fraction of the water** causes a variety of **undesirable on-site and off-site effects** ranging from water-logging and salinity within the irrigated area to downstream water pollution.

BACKGROUND (CONT.)

- Good irrigation management practices reduce **the need for artificial drainage.**
- It also reduces the **negative effects of irrigated agriculture on the pollution of the terrestrial and aquatic environment by nutrients in drainage effluents**.

BACKGROUND (CONT.)

- To this end, water balance components needs quantifying precisely in any large scale irrigation district for a certain period of time.
- **The more reliable water balance, the more dependable mass balance for irrigation-induced pollution control.**

OBJECTIVES

- **To make a water balance work in a large scale irrigation scheme to assess sustainability of existing irrigation management.**
- **To quantify nitrogen balance elements for sound and effective nitrate loads monitoring in irrigation return flows (IRFs).**

A CASE STUDY

Area
9,495 ha

Climate
Mediterranean

Precipitation
650 mm

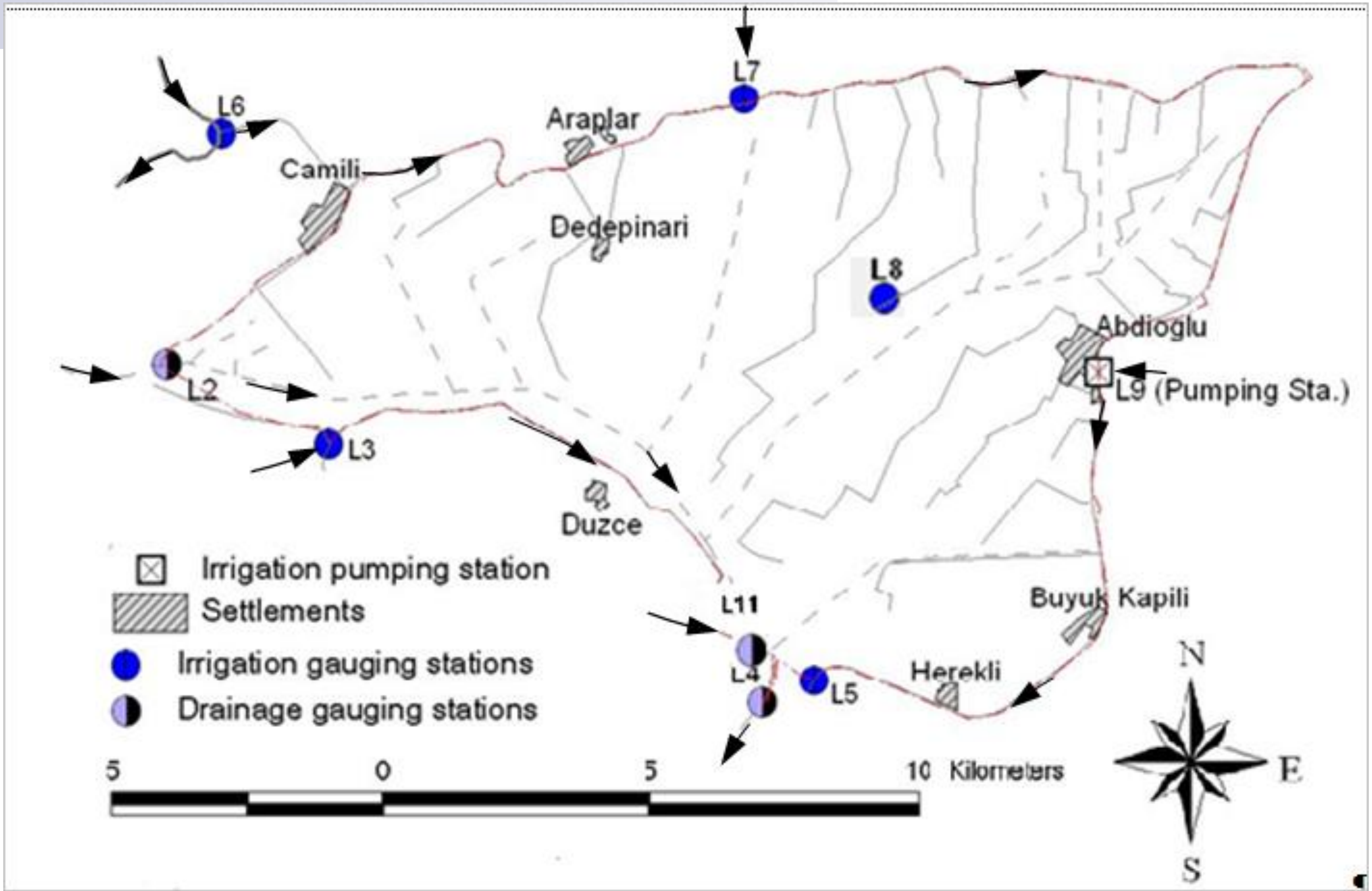
Average Temperature
18 ºC

Water source
Seyhan dam

Crops
Summer: Maize, Cotton
Winter: Wheat

Evergreen: Citrus

HYDROLOGICAL AND HYDRO-METEOROLOGICAL OBSERVATIONS



Irrigation gauging stations : L3, L5, L6, L7, L9

Drainage gauging stations : L2, L4, L11

WATER BALANCE CLOSURE ERROR EVALUATION

$$\Delta W = I + P - ETc - IRF$$

$$\Delta(error\ balance\ (\%)) = \frac{inputs - outputs}{inputs + outputs} * 200$$

ΔW : Closure error (mm)

I : Irrigation (mm)

P : Rainfall (mm)

ETc : Crop irrigation water equirements (mm)

IRF : Drainage (Irrigation return flows (mm))

IRRIGATION WATER MANAGEMENT INDICES FOR THE AGRICULTURAL CATCHMENT

Leaching fraction ➔ $$LF = \frac{I + P - ET_c}{I + P} * 100$$

Drainage fraction ➔ $$DF = \frac{IRF}{I + P} * 100$$

District irrigation efficiency ➔ $$DIE = \frac{ET_c - P_e}{I} * 100$$

NITROGEN BALANCE WORK AND LOAD QUANTIFICATION IN IRFs AT THE CATCHMENT LEVEL

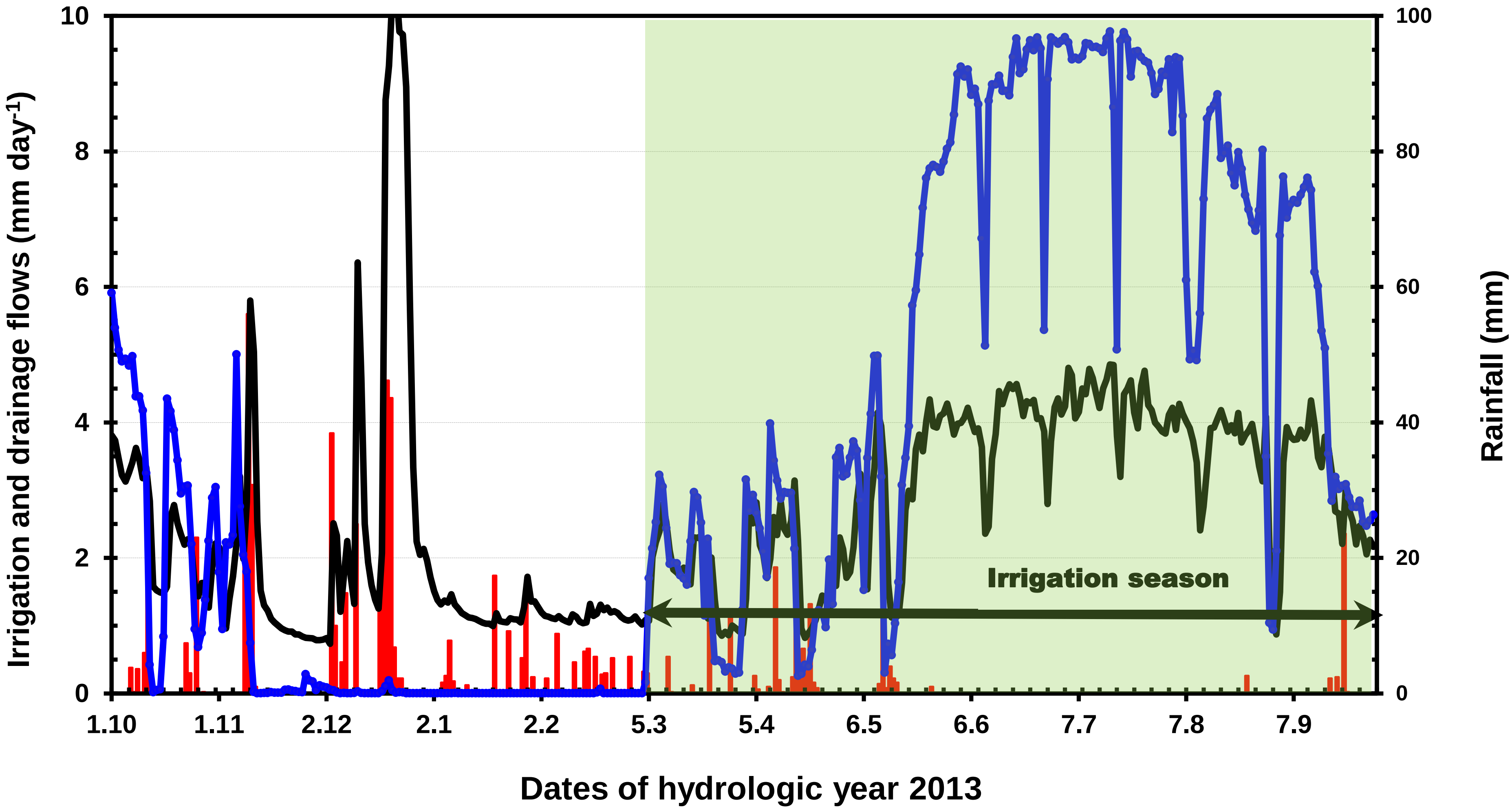
Water sampling was done as the following.

Irrigation water: biweekly,
Drainage waters: daily,
Rainfall: at every rain-event.

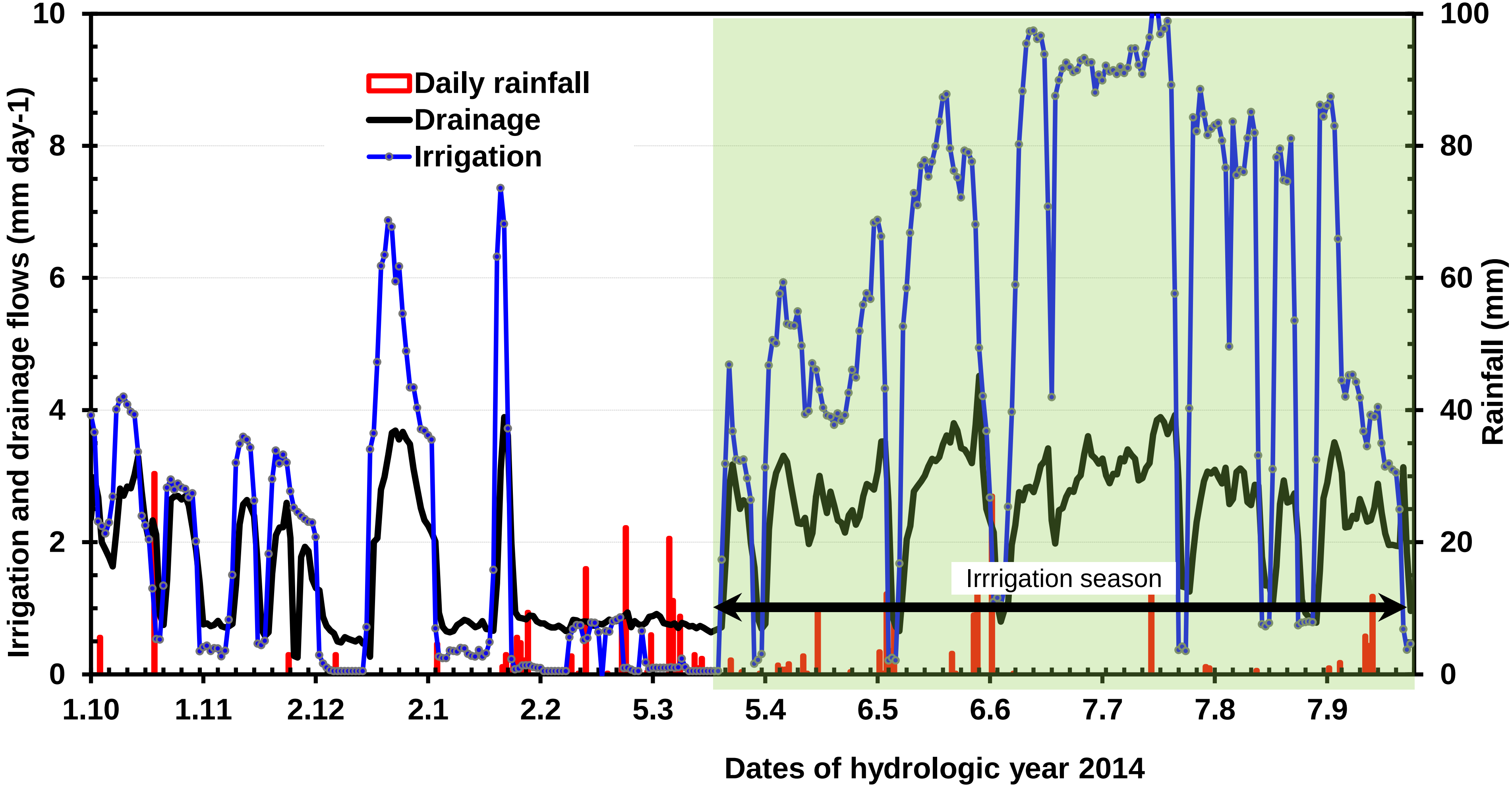
Nitrate concentrations of the collected water samples were determined and used in load calculations.

FINDINGS

HYDROLOGICAL REGIME IN THE AGRICULTURAL CATCHMENT



HYDROLOGICAL REGIME IN THE AGRICULTURAL CATCHMENT



WATER BALANCE AT THE IRRIGATION SCHEME LEVEL

	HY	IS	NIS	% of total in NIS
		2013		
Rainfall (P, mm)	758	187	570	75.3
Irrigation(I, mm)	1284	1165	119	9.2
Drainage(Q or IRF, mm)	973	650	323	33.2
ETc (mm)	834	612	222	26.7
Peff (mm)	411	71	340	82.6
ΔW (closing error, mm)	236	91	145	-
ΔW (%) over total inputs	12	7	21	-
Δ (error balance, %)	12	7	23	-

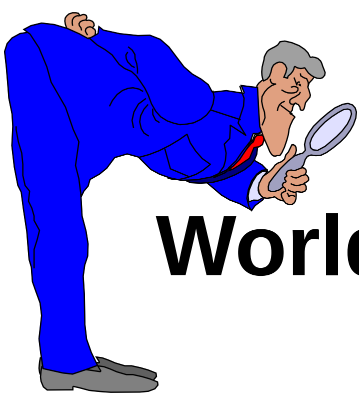
WATER BALANCE AT THE IRRIGATION SCHEME LEVEL

	HY	IS	NIS	% of total in NIS
			2014	
Rainfall (P, mm)	321	145	177	55
Irrigation (I, mm)	1389	1109	280	20
Drainage(Q or IRF, mm)	741	496	245	33
ETc (mm)	834	612	222	27
Peff (mm)	99	35	64	65
ΔW (closing error, mm)	137	147	-10	-
ΔW (%) over total inputs	8	12	-2	-
Δ (error balance, %)	8	12	-2	-

WATER BALANCE terms could be determined precisely, indicating that NITROGEN mass balance works could be performed in a SOUND WAY!

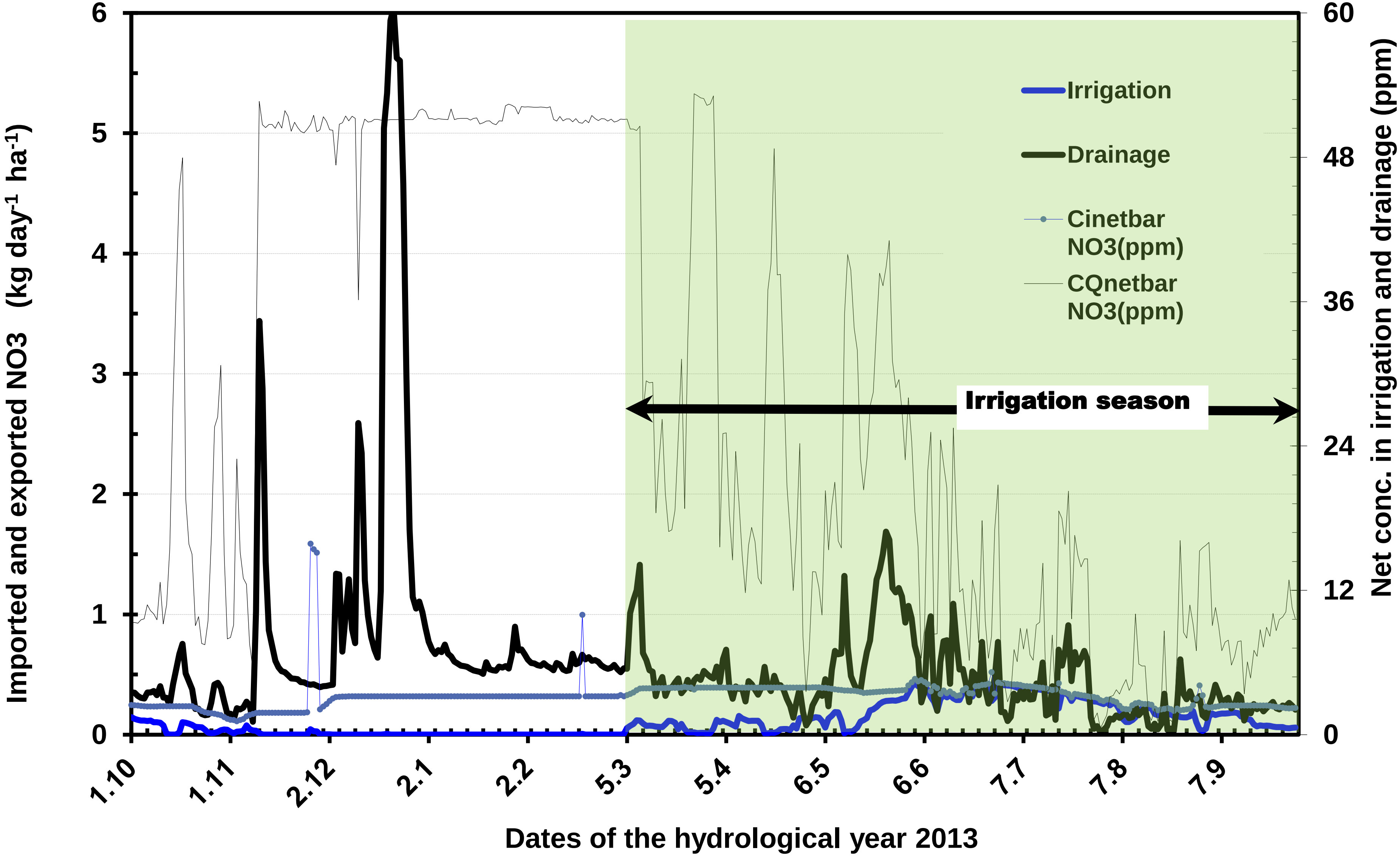
IRRIGATION PERFORMANCE INDICES

	HY	IS	NIS	HY	IS	NIS
		2013			2014	
DIE (%)	33	46	-	53	52	-
WUE (%)	41	45	32	49	49	49
DF (%)	48	48	47	43	40	54
LF (%)	59	-	-	51	-	-

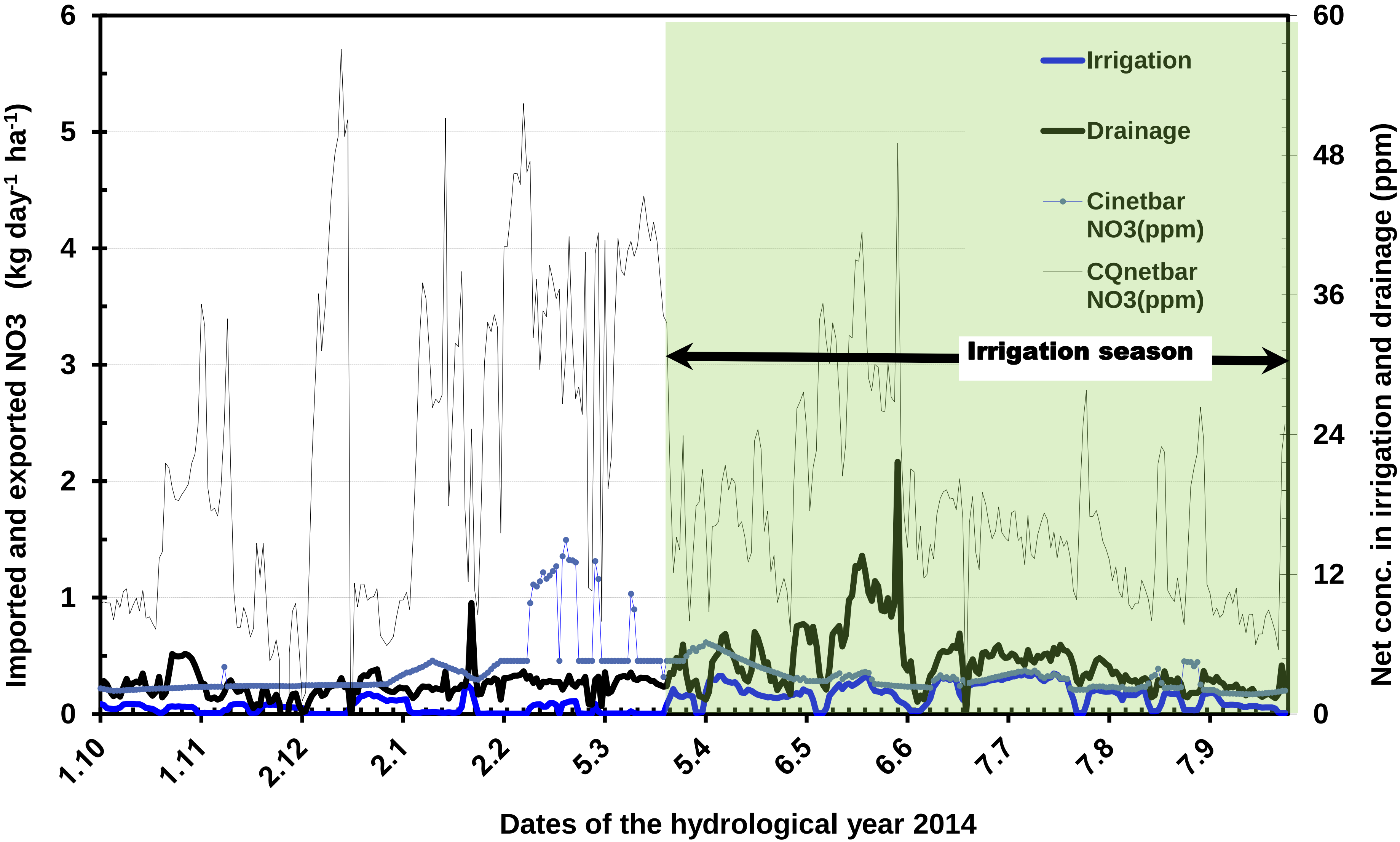


World average of DIE=38%!!!

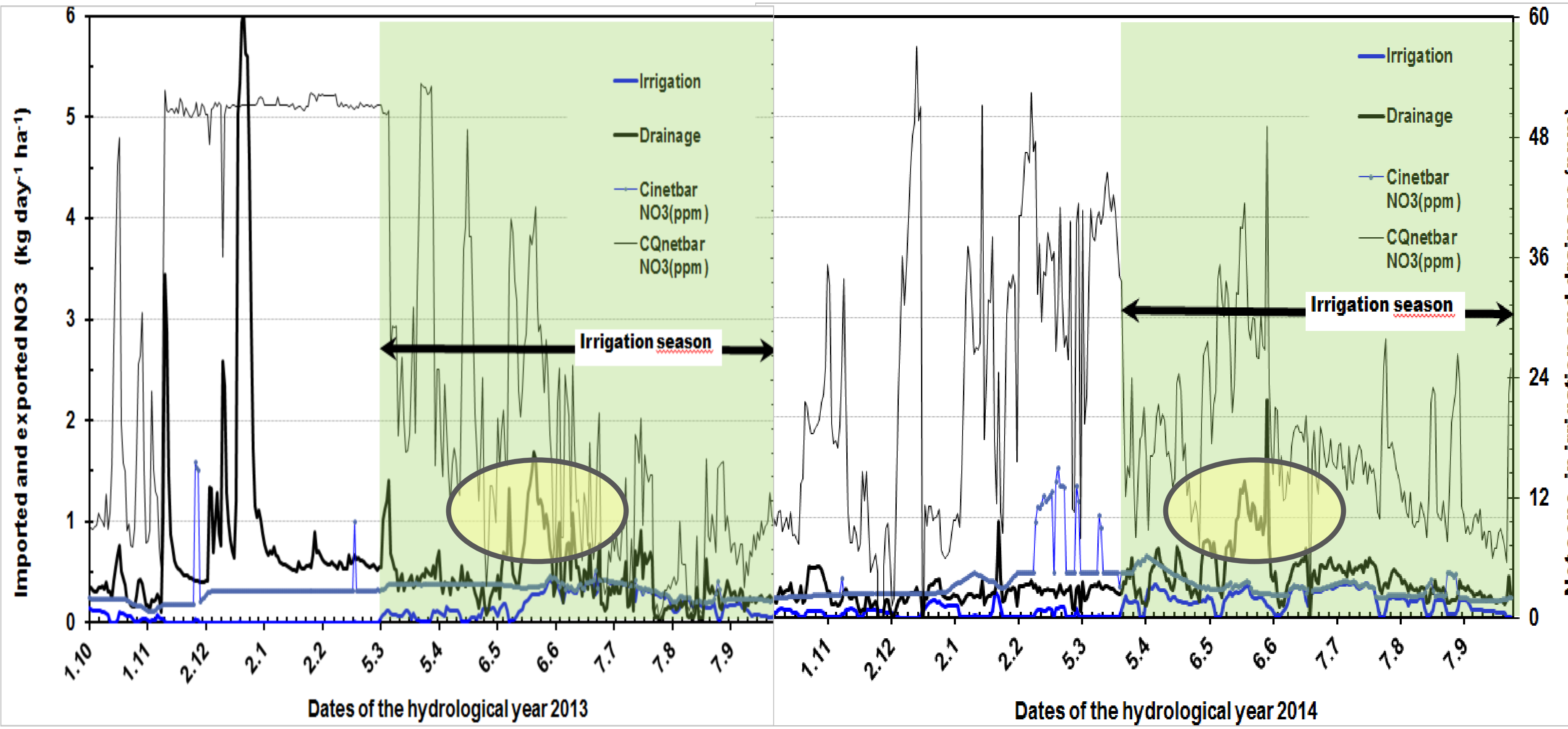
NO3 DYNAMICS IN THE AGRICULTURAL CATCHMENT



NO3 DYNAMICS IN THE AGRICULTURAL CATCHMENT



NO3 DYNAMICS IN THE AGRICULTURAL CATCHMENT



NITROGEN BALANCE AT THE IRRIGATION SCHEME LEVEL

kg NO3-N ha^{-1}	HY	IS	NIS	% of total in NIS
		2013		
Rainfall	14	10	4	29
Irrigation	9	9	1	6
Drainage	52	21	31	59
Fertilizer	307	-	-	-
N-Uptake by Crops	190	-	-	-
ΔNO3-N	88	-	-	-
Δ (error balance, %)	31	-	-	-
NUE=(1-NQ/NF)*100	83	-	-	-

NITROGEN BALANCE AT THE IRRIGATION SCHEME LEVEL

kg N ha^{-1}	HY	IS	NIS	% of total in NIS
		2014		
Rainfall	12	6	6	48
Irrigation	10	8	2	20
Drainage	29	19	9	32
Fertilizer	297	-	-	-
N-Uptake by Crops	186	-	-	-
ΔNO_3-N	104	147	-10	-
Δ (error balance, %)	39	-	-	-
NUE=(1-NQ/NF)*100	90	-	-	-

CONCLUSIONS & RECOMMENDATIONS

- ✓ Hydrological water balance work resulted in acceptable closure errors at the irrigation scheme level.
- ✓ Exact water balance work enabled us to:

(1) **DETERMINE** irrigation performance indices,

(2) **CONDUCT** nitrogen mass balance work at the irrigation district level.

- ✓ Existing irrigation management was poor and not sustainable in terms of water saving and ENVIRONMENTAL CONCERNS OF IRRIGATED AGRICULTURE.

CONCLUSIONS (CONT.)

- ✓ **Fertilizer applications were 307 and 297 kg N per ha, plant uptakes were 190 and 186 kg N per ha in 2013 and 2014, respectively.**

- ✓ **Nitrogen balance work was resulted in a closure error of 31 and 39% in 2013 and 2014.**

- ✓ **Nitrogen losses (N_Q/N_F*100) to the drainage systems were low 17 and 10% during the respective wet and dry year as total of 52 and 29 kg N per ha in the consecutive years.**

CONCLUSIONS (CONT.)

- ✓ The results suggested that water management was not only a problem, but N fertilizer management was also a challenging issue to set the scene for sustainability of agriculture at the catchment level.
- ✓ Findings need being shared among the government officers, experts, stakeholders and local farmers to take effective mitigating measures for environmental, social and economical development of the region.

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