Surface and ground water monitoring:

hydrological – physicochemical – chemical monitoring

&

aquatic biomonitoring

Polina Polykarpou
Biologist
Division of Hydrometry
Water Development Department, Nicosia, Cyprus
ppolykarpou@wdd.moa.gov.cy

Dec. 08-09, 2022

A. SURFACE water monitoring

(*WDD – Division of Hydrometry*)

WATER FRAMEWORK DIRECTIVE 2000/60/EC

***NATURAL* LAKES: temporary, shallow, brackish – saline – hypersaline**

Monitoring programs in 10 Lakes (28 sampling & monitoring stations):

- 13 monitoring and sampling stations:
  1. aquatic biomonitoring & chemical monitoring
  2. measurements of *in situ* hydrological & physical-chemical parameters
- 15 *in situ monitoring* stations: measurements of hydrological & physical-chemical parameters

A. FIRST EVALUATION OF WATER QUALITY

According to programs which have **established preliminary reference conditions** for the temporary salt lakes of Cyprus:

- 4 different types of lakes (salinity, hydrological regime, morphology)
- **Phytoplankton** & **zooplankton:** considered the most useful biological quality elements (BQE's) for assessment and are examined in the monitoring programs
- **Macrophytes** are examined (if found)
- **Salinity** (& **hydrological status**) seem to shape the communities of salt lakes primarily and then the availability of nutrients

B. *In situ* MONITORING stations

physical, chemical & hydrological parameters*:*

- temperature
- pH
- dissolved oxygen
- electrical conductivity & salinity
- turbidity
- water level

frequency:

2019 & before: EVERY 1 or 2 WEEKS in some lakes

2020 – today: MONTHLY in 15 stations

C. *In situ* MONITORING & SAMPLING stations

C1. In *WATER COLUMN*:

- **physical, chemical & hydrological parameters** *(in situ)*
- **nutrients, priority substances, chemical & microbiological parameters, ions, heavy metals:** examined since 2017
- **phytoplankton (composition – abundance – biomass & chlorophyll *a*):** examined since 2014
- **zooplankton:** examined since 2014
- **macrophytes:** examined (if found) since 2019

phytoplankton

zooplankton

macrophytes

C. *In situ* MONITORING & SAMPLING stations

frequency:

2019 & before: EVERY 1 or 2 WEEKS in some lakes

2020 – today: MONTHLY in 13 stations

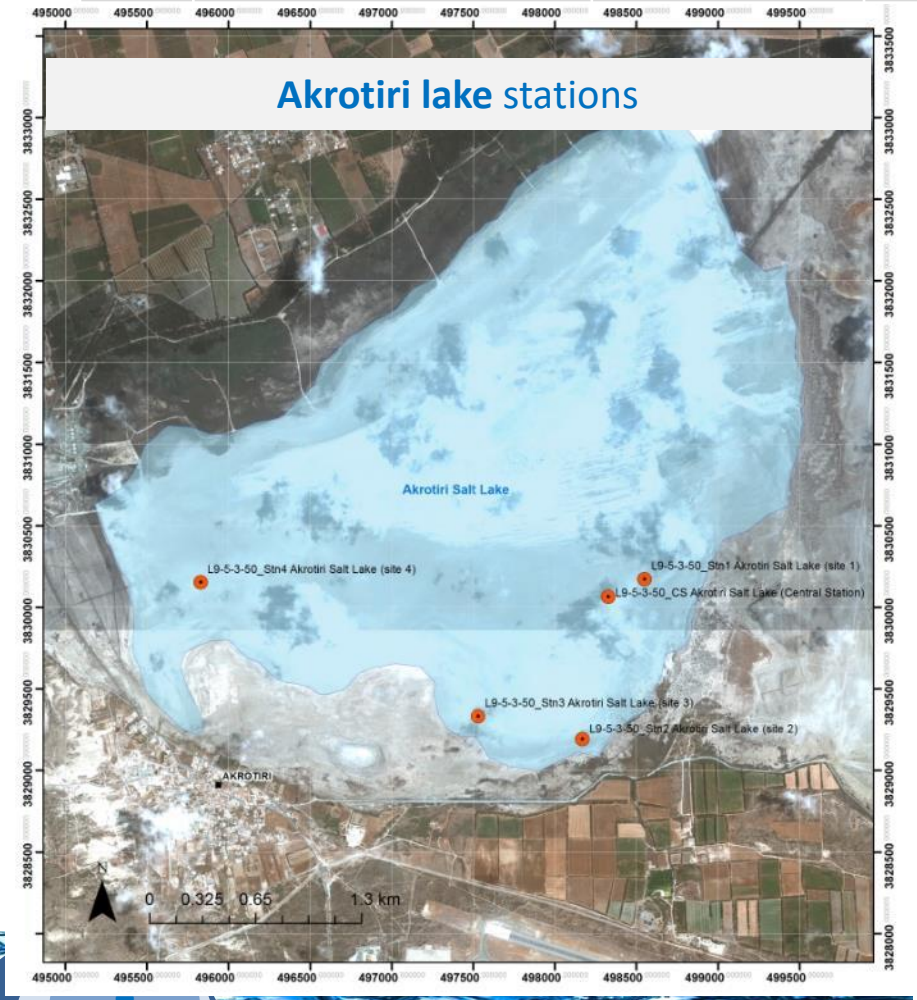
C2. In SEDIMENT:

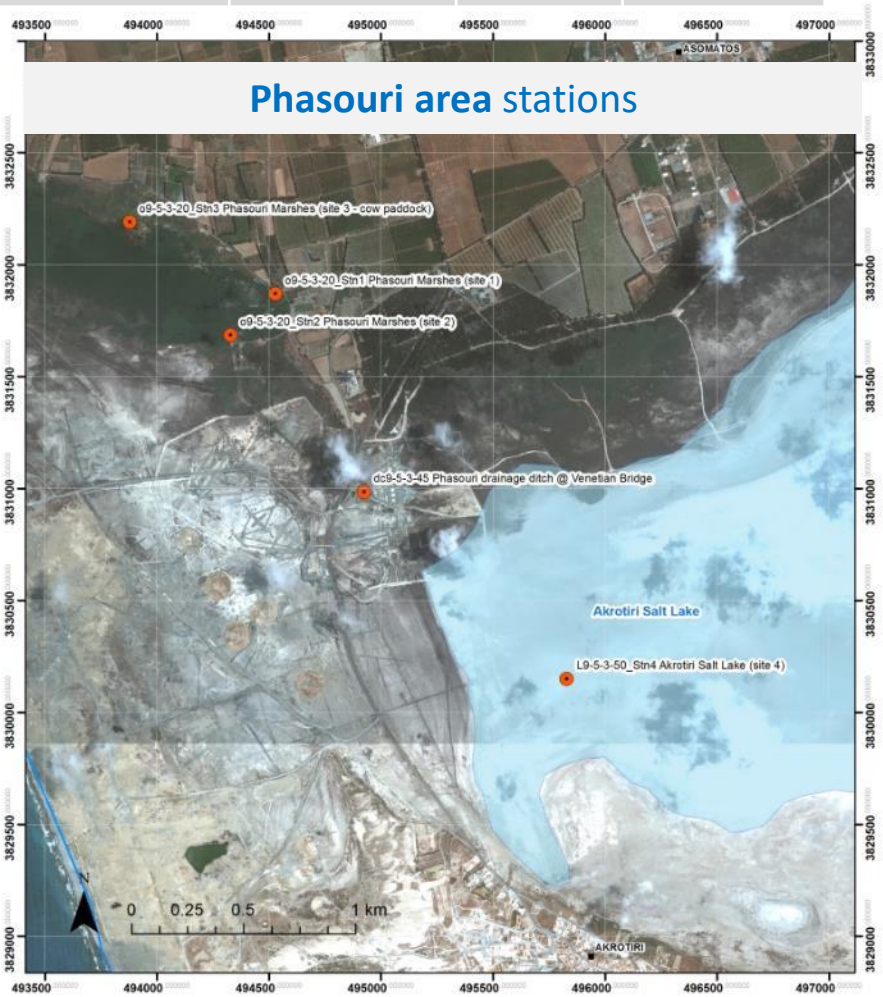
priority substances, chemical parameters, heavy metals etc.

frequency:

2017 – today: 1 / year in 7 stations (one per lake)

type	lake	salinity	hydrological regime	morphology	altitude	area
LB2	1. Akrotiri 2. Aerodromiou no.2	saline to hyper-saline	without drainage	coastal, shallow, temporary	low	semidry-dry





D. MONITORING & SAMPLING OUTCOMES

Hydrological status was stable during the last 3 decades:

Station 1 *

Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1988	0.08	0.19	0.4	0.23		0.13						
1989		0.14	0.15	0.09								0.03
1990		0.22	0.2									
1991		0.01									0	0.02
1992	0.39	0.6	0.47	0.42	0.23	0.3	0.12				0	0.18
1993	0.19	0.23	0.41	0.37	0.18						0	
1994	0	0.07	0.24	0.16								0.2
1995	0.26	0.35	0.32	0.24	0.08	0.03						
1996				0.02	0						0	0
1997	0	0.04	0.03	0.07	0					0.01	0	0.09
1998	0.02	0	0.06		0						0	0.03
1999	0.08	0.15		0								
2000	0	0	0.01	0								0.06
2001	0.22	0.26	0.25	0.1	0.07							0.08
2002	0.18		0.13									
2003	0.01	0.5	0.42	0.38		0.18					0	0.04
2004	0.55		0.8	0.75	0.58							
2005	0.36	0.7	0.65	0.6	0.5						0	0
2006		0.08	0								0.05	
2007	0.04	0.26		0.26	0.09							
2008	0											0
2009	0.3	0.07		0.17	0.02						0.04	
2010			0.1	0.1	0.03							
2011	0.07				0.25							0
2012	0.55			0.21		0						
2013	0	0.63		0.65		0.35				0		
2014	0.21	0.29	0.46	0.08								0
2015	0.35	0	0.42	0.68	0.44	0.16	0.13				0	
2016		0.18		0.08								
2017		0.49	0.52	0.46	0.32	0.2						
2018		0.26	0.29	0.26	0.11							

Station 4 *

Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1988	0.04	0.17	0.28	0.24		0.06						
1989	0.03	0.02	0.05	0								0
1990	0	0.17	0.03									
1991		0	0								0	0
1992	0.5	0.5	0.42	0.28	0.24	0	0				0	0.06
1993	0.19	0.25	0.4	0.33	0.2	0					0	
1994	0.01	0	0.19	0.08								0.16
1995	0.2	0.29	0.23	0.23	0.1	0.01						
1996				0	0						0	0.07
1997	0.08	0	0.02	0	0					0	0	0.01
1998	0	0.15	0	0	0						0	0
1999	0.2	0.03		0.2								
2000	0	0	0	0								0.01
2001	0.17	0.16	0.24	0.09	0.02							0
2002	0.22		0.2									
2003	0	0	0.37	0.34		0					0	0
2004	0.6		0.8	0.7							0	
2005	0.34	0.64	0.6	0.65	0.45						0	0.03
2006		0.17	0.1		0						0	
2007	0	0.21		0.23	0.03							
2008	0											0
2009	0	0.1		0.06	0						0	
2010		0.3	0.2	0.08	0.03							
2011	0.03		0.19		0							0
2012	0.45			0.22		0.48						
2013	0.65	0.63		0.48		0.2				0		
2014	0.18	0.18	0.33	0.25								0.05
2015	0.08	0.65	0.3	0.44	0	0	0				0	
2016		0		0								
2017		0.33	0.35	0.38	0.18							
2018		0.12	0.2	0.11								

BUT has changed after 2019:

minimum water level is recorded after August

in the deepest station:

2019	0.49	0.87	0.92	0.97	0.83	0.71	0.54	0.3	0.17				0.25
2020					0.79	0.7	0.5		0.29	0.19			0.44
2021	0.64	0.65	0.7	0.7	0.55	0.4	0.25	0.05	0	0	0	0	0.24
2022	0.6	0.85	0.89	0.79	0.7	0.5	0.38	0.11	0.06	0.09			

and in the shallowest station:

2019	0.33	0.68	0.73	0.78	0.64	0.55	0.38	0.05					
2020					0.61	0.55	0.39		0.2	0.06			0.3
2021	0.43	0.65	0.6	0.52	0.4	0.25	0.12	0	0	0	0	0	0.1
2022	0.48	0.7	0.75	0.65	0.59	0.44	0.2	0	0	0			

* 1988 – 2016: Department of Fisheries and Marine Research data
2016 – 2022: data collected by Water Development Department

D. MONITORING & SAMPLING OUTCOMES

- **Phytoplankton** and **zooplankton** knowledge is limited for these unique types of lakes

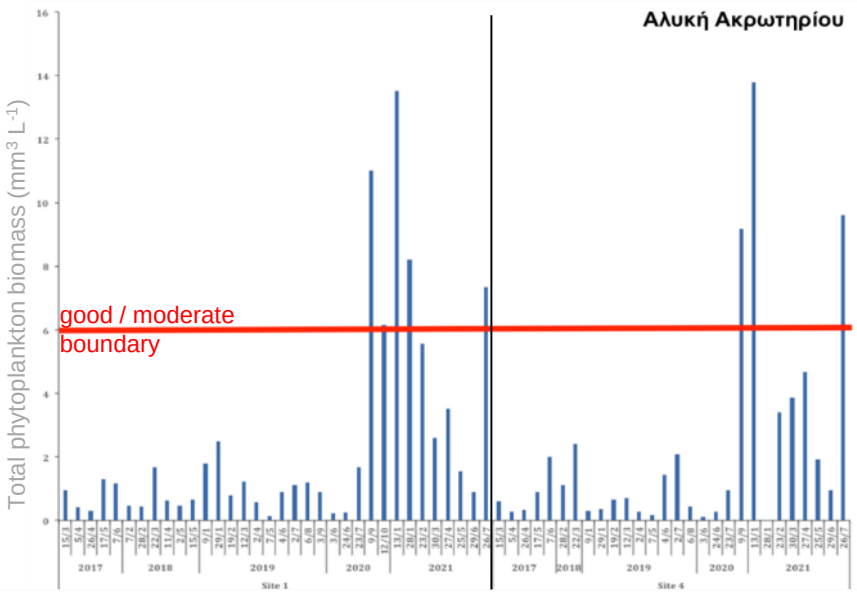
  (very shallow temporary saline/hypersaline lakes)
- **No method** yet for assessing the ecological quality, according to WFD 2000/60/EC
- Preliminary reference conditions were set for phytoplankton and zooplankton
- Extra data is collected frequently, to develop an **assessment method** for Cyprus natural lakes (i.e. to set the high-good, good-moderate **boundaries** etc.)
- **Salinity** seems to affect the communities of salt lakes primarily BUT recent data suggest that **bottom-sediment** effect is huge…

E. WATER QUALITY – 3rd RBMP

Phytoplankton in 2017-2021 (st. 1 & 4):

- 6 taxonomic groups (**cyanobacteria**, **diatoms/bacillariophyceae**, **chlorophyceae**, dinophyceae, cryptophyceae, pyramimonadophyceae)
- most important groups in terms of phytoplankton **BIOMASS**:

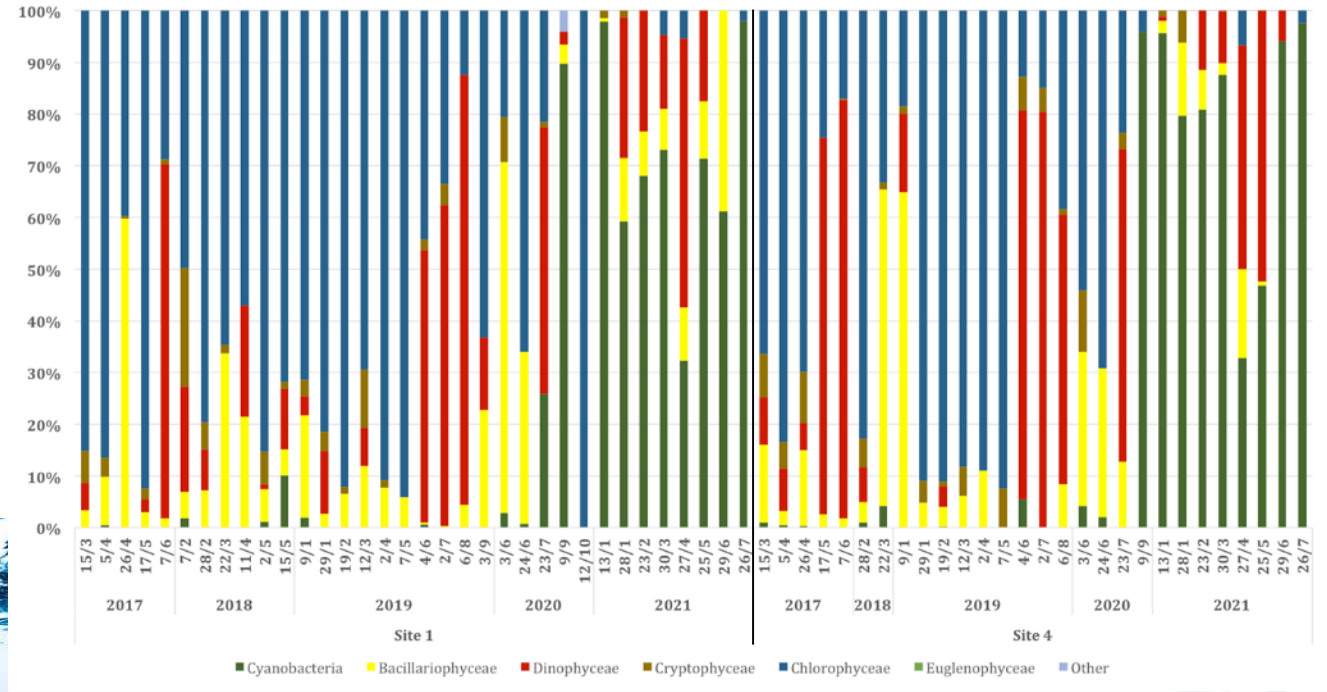
  chlorophyceae, diatoms & dinophyceae



- **BUT:**

During 2021, **cyanobacteria** became the most important group

coccoid & rod-shaped cyanobacteria blooms were recorded



E. WATER QUALITY – 3rd RBMP

According to preparatory studies that will be the basis for the preparation of the **3rd River Basin Management Plan**:

period 2014-2019

- based on *phytoplankton:* Akrotiri salt lake has **unknown** ecological status, or **lower than good** ecological status.
- based on *zooplankton* and the *physicochemical parameters:* it appears that ecological **reference conditions** were not achieved
- Akrotiri salt lake **failed to achieve good** chemical status, due to:

  nickel, hexachlorobenzene (fungicide) & chlorpyrifos (pesticide)

CODE	NAME	ECOLOGICAL STATUS/POTENTIAL	CHEMICAL STATUS
CY_L9-5-3-50	Akrotiri lake	Unknown quality *	Failing to achieve good

** Due to the lack of sufficient data for the years 2014-2017, 2018-2019 result is adopted as representative for the entire evaluation period.*

B. GROUND water monitoring

WATER FRAMEWORK DIRECTIVE 2000/60/EC

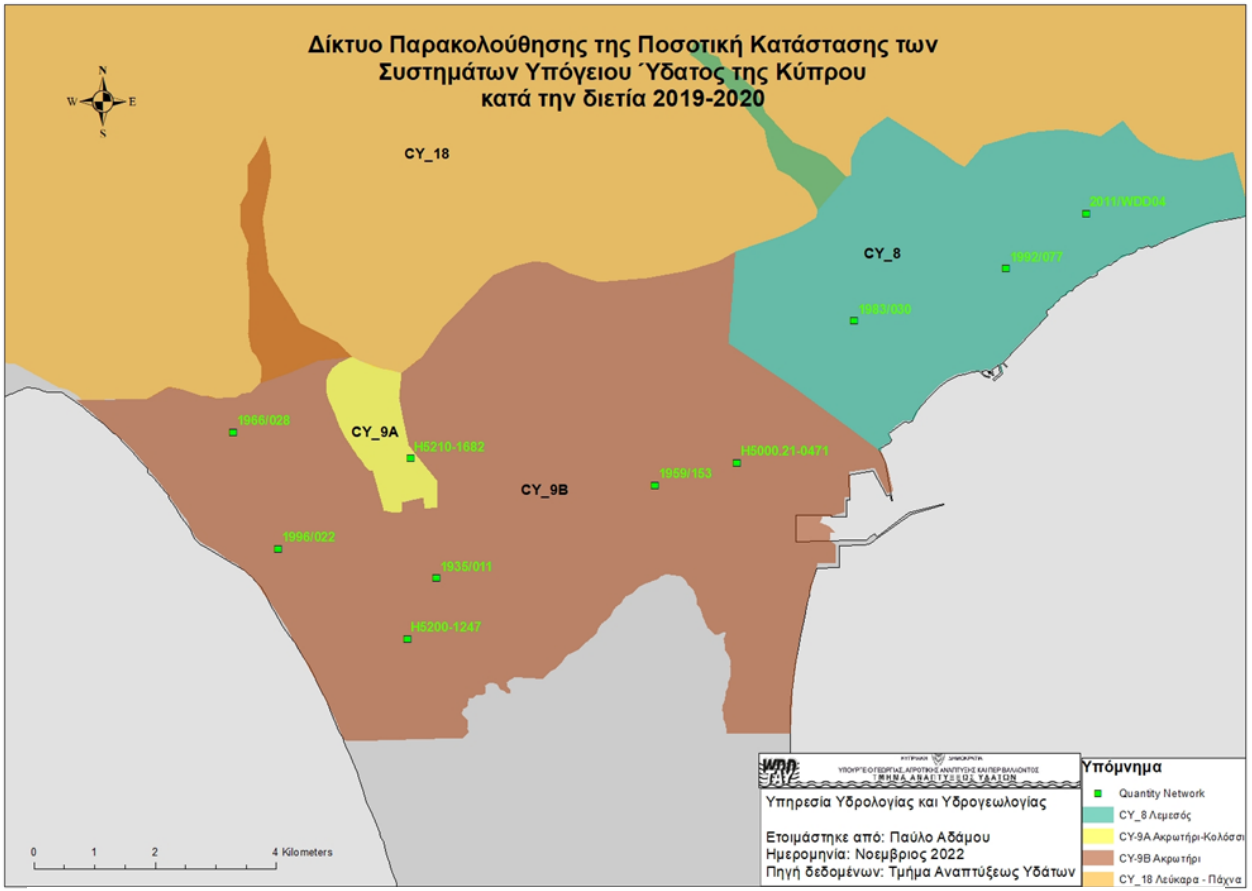
Groundwater:

2019: review, revision and recharacterization of Groundwater Systems (Article 5)

WDD – Division of Hydrology

Separation of CY-9 Akrotiri - Kolossi Groundwater System, due to different pressures and use:

- **CY-9A Akrotiri – Kolossi** groundwater system (*domestic water supply*)
- **CY-9B Akrotiri** groundwater system (*for irrigation use*)



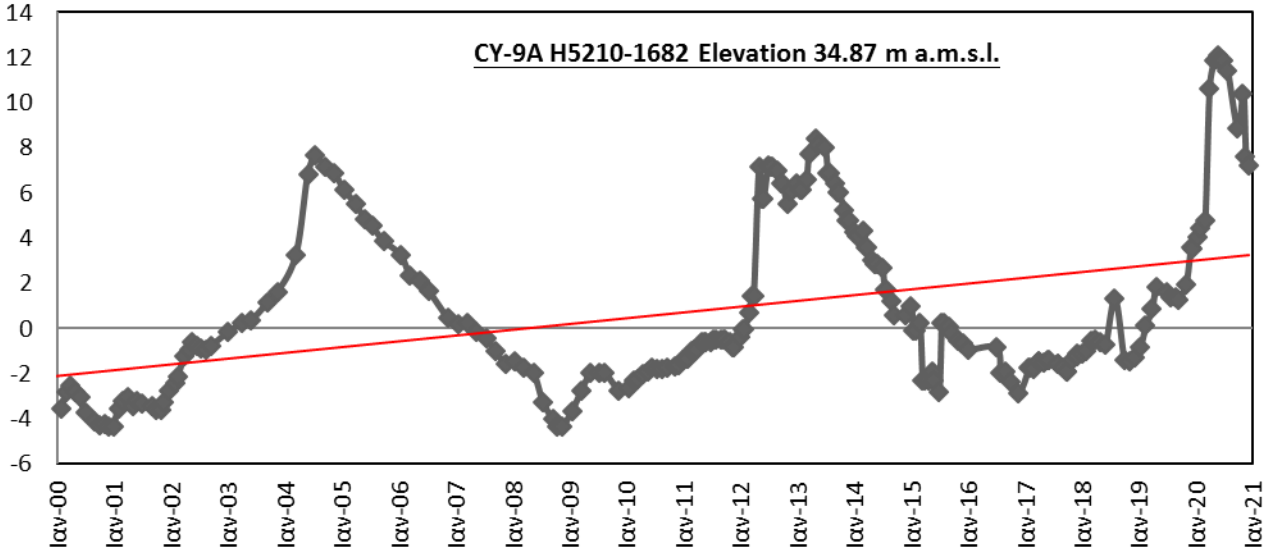
http://www.moa.gov.cy/moa/WDD/wfd.nsf/All/A1187B00545D7D16C22586930029371A?OpenDocument

A. QUANTITATIVE STATUS

2019-2020: **CY-9A** Akrotiri – Kolossi groundwater system

POOR status:

- intensive pumping for water supply
- DESPITE the increase the average value of the water level, due to the increase of precipitation



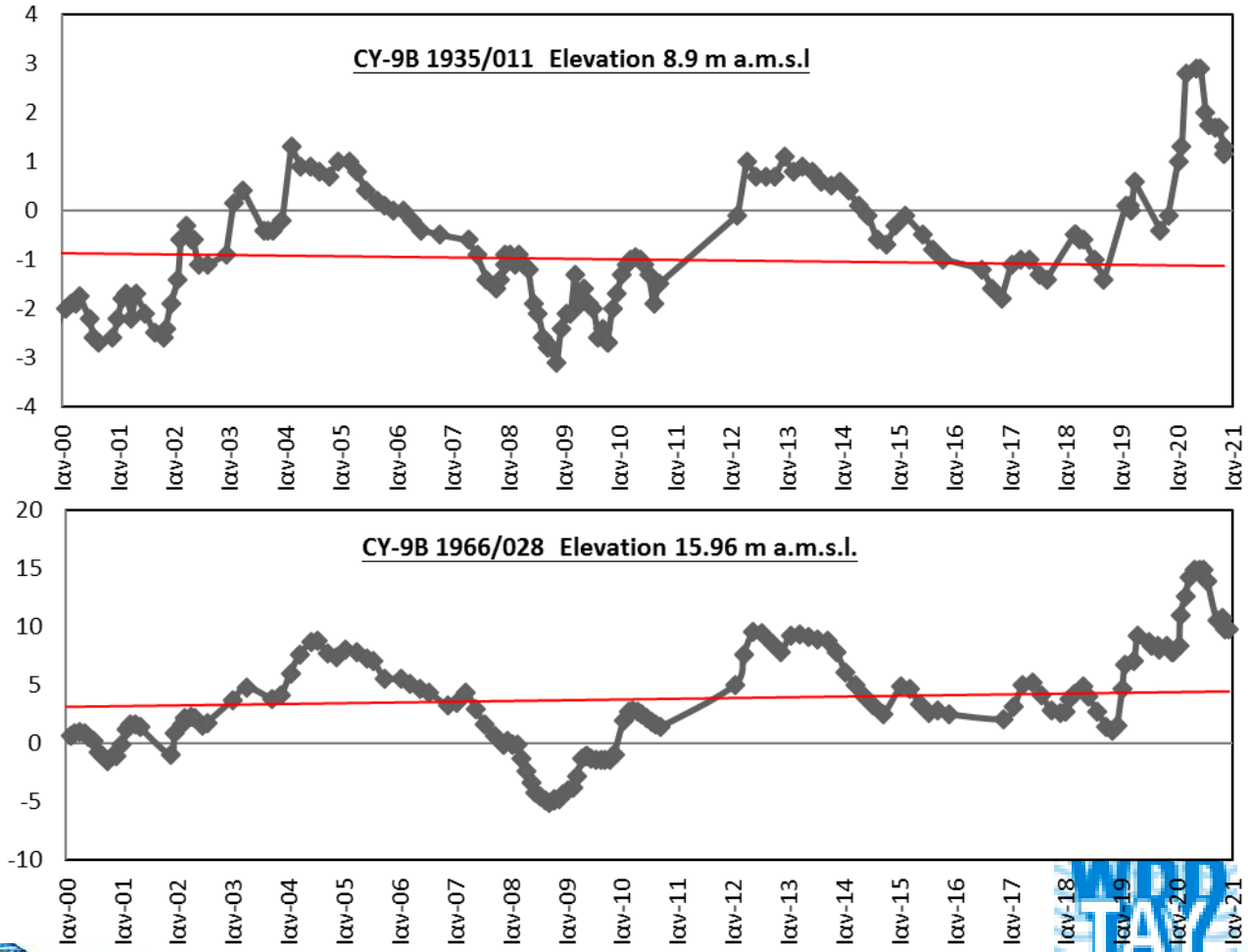
Chemical and quantitative status of groundwater systems:
http://www.moa.gov.cy/moa/wdd/wdd.nsf/page11_gr/page11_gr?opendocument

A. QUANTITATIVE STATUS

2019-2020: **CY-9B** Akrotiri groundwater system

POOR → GOOD status:

- increase in rainfall
- decrease in pumping for irrigation (although sea intrusion is observed in some places)

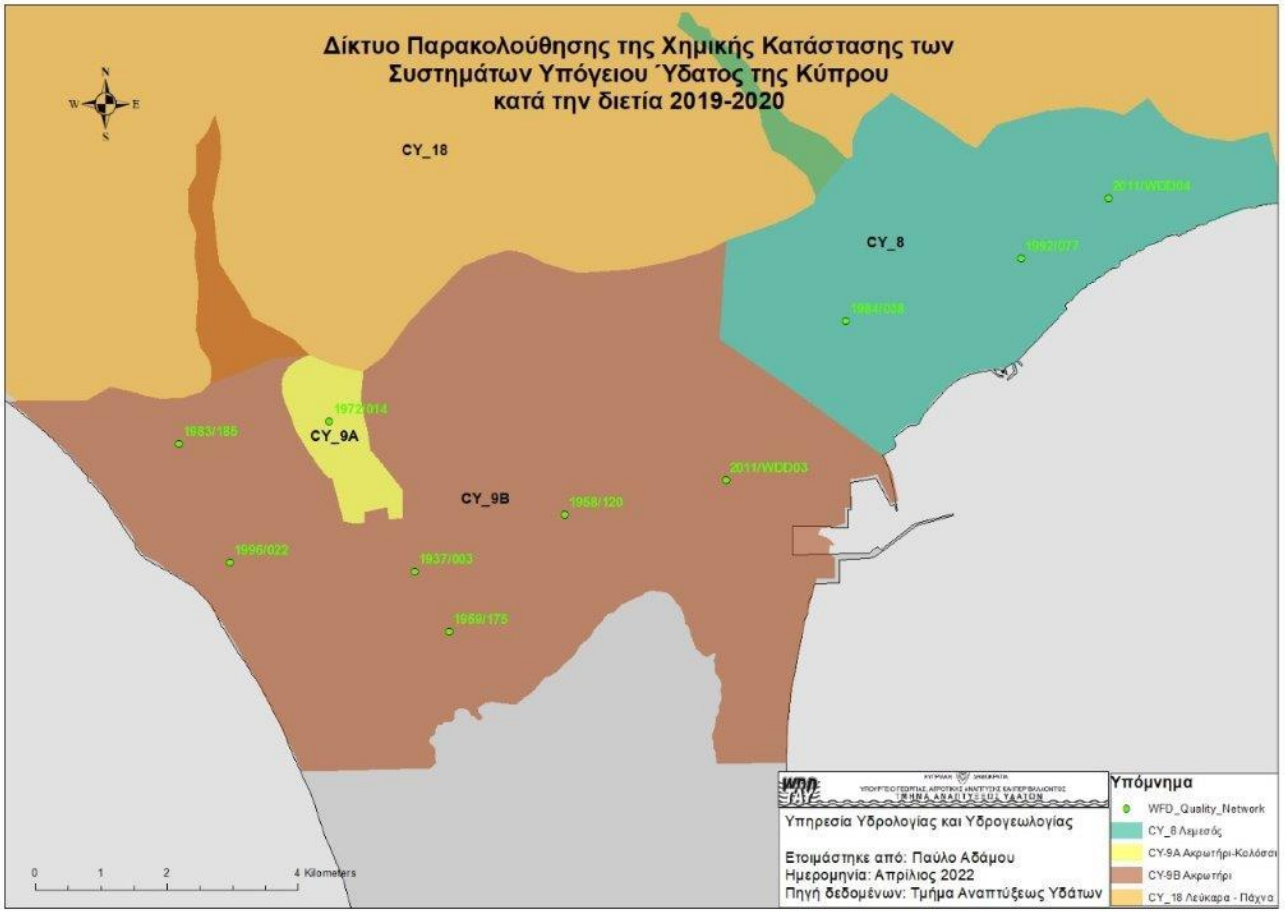


B. CHEMICAL STATUS

2019-2020: **CY-9A** Akrotiri – Kolossi groundwater system

GOOD status:

- Upper Acceptable Values of chemical pollutants and their indicators were determined based on the European Directive 98/83/EC concerning the quality of water for human consumption

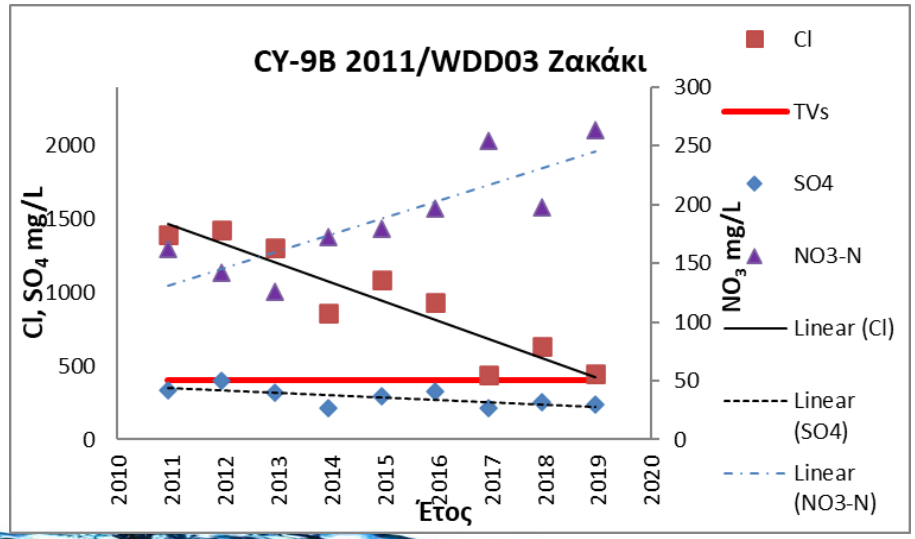


B. CHEMICAL STATUS

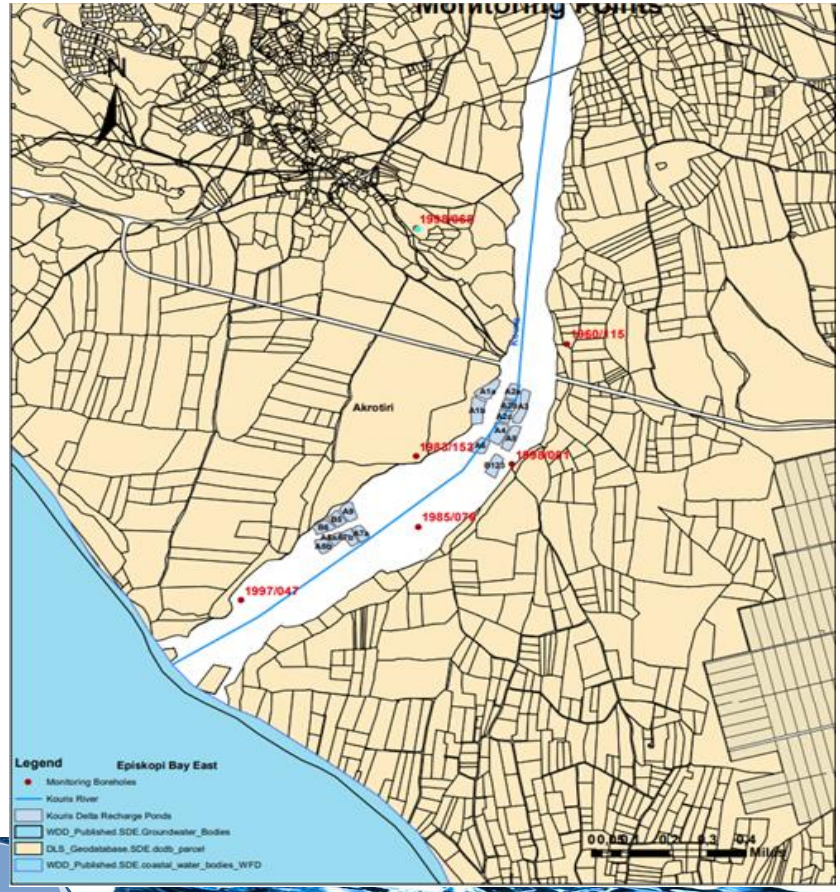
2019-2020: **CY-9B** Akrotiri groundwater system

POOR status:

- DESPITE the **downward trend** of: *chloride ions*, *sulfate ions* & *conductivity* (long-term intensive pumping → consequent inflow of sea water into the aquifer)
- *Nitrates* have an a **upward trend** – exceed their Upper Acceptable Values (due to the increase of precipitation)



Akrotiri underground aquifer used to have
POOR QUANTITATIVE & CHEMICAL status, due to sea intrusion:
→there was a need to restore it
→recycled water is used for its artificial recharge



- ✓ *WDD – Limassol District office:* responsible for the wastewater distribution (agriculture, Polemidia dam, aquifer, sea).
- ✓ Artificial recharge takes place during the rainy season, when irrigation demand is very low or zero (November- April)

Akrotiri artificial recharge monitoring program:

WDD – Division of Hydrometry

Started in December 2015 (xenobiotics in 2017 – request by the community council of Akrotiri)

- ✓ 1 time before recharge (Oct/Nov)
- ✓ 2 times during recharge (Jan/Feb)
- ✓ 1 time at the end (May/June)

***IN**: 5 boreholes, Kouris Delta Recharge Pond & SALA pipeline outfall*

Parameters examined in

a. groundwater (4 times / year)

b. surface water (recharge ponds, 2 times / year)

c. pipeline (2 times / year)

COD, BOD5, TSS, TOC

N_Total, NO3-N, NO2, NH4-N, P_Total

Metals (As,Cd,Pb,Hg)

TriClEthylen, TetraCleth, Pesticides

Microtox test, Daphtox test, Algatox Test

E.coli/100mL, Enterococci/100 ml, Total Coliforms/100mL

Xenobiotics (since 2022)

Thank you

Aknowledgements:
WDD – Div. of Hydrometry: *G. Dörflinger, F. Ioulianou*
WDD – Div. of Hydrology: *P. Adamou*
WDD – Limassol District office: *A. Thoma*

Polina Polykarpou
Biologist
Water Development Department, Nicosia, Cyprus
ppolykarpou@wdd.moa.gov.cy