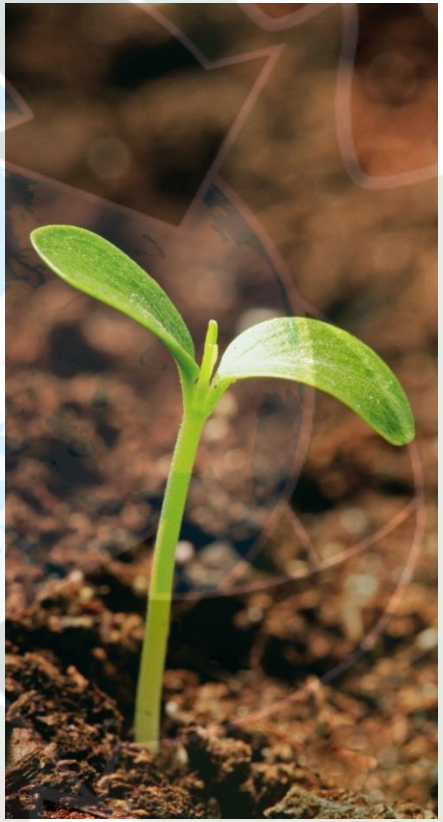
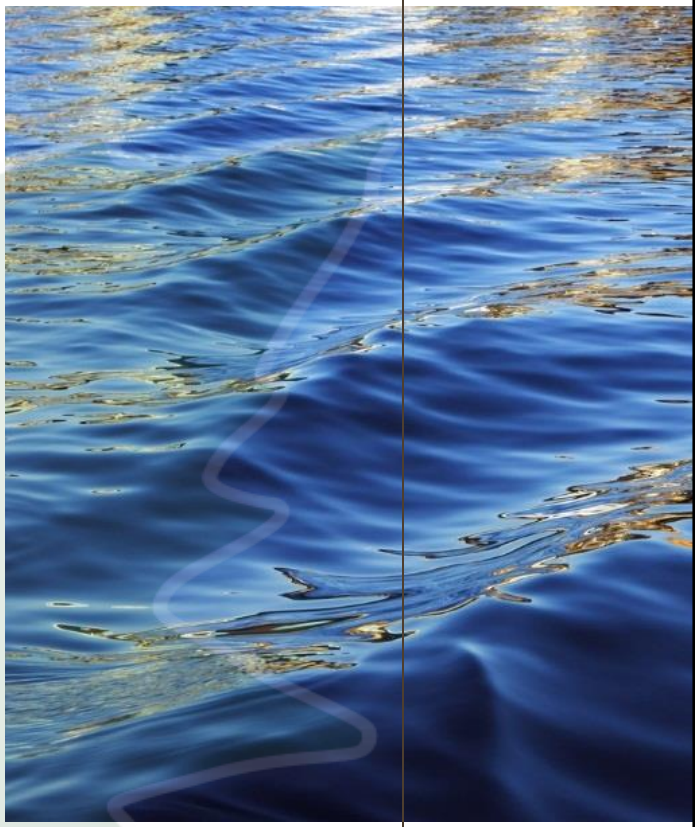
Ecological risk assessment of nutrients discharges from Danube River to the Black Sea

POPESCU Iustina, DEÀK György, DOROBANȚU Gabriela, TĂNASE Georgiana

INCDPM - National Institute for Research and Development in Environmental Protection, Bucharest, ROMANIA





Eutrophication

- Represents enrichment of water by nutrients, especially compounds of nitrogen and/or phosphorus, causing an accelerated growth of **algae** [Directive 91/271/EC]:

$$106CO_2 + 16NO_3^- + HPO_4^{2-} + 122H_2O + 18H_2 \rightarrow C_{106}H_{263}O_{110}N_{16}P + 138O_2 + 18HCO_3^-$$

$$16NH_4^+ + 92CO_2 + HPO_4^{2-} + 92H_2O + 14HCO_3^- \rightarrow C_{106}H_{263}O_{110}N_{16}P + 106O_2.$$

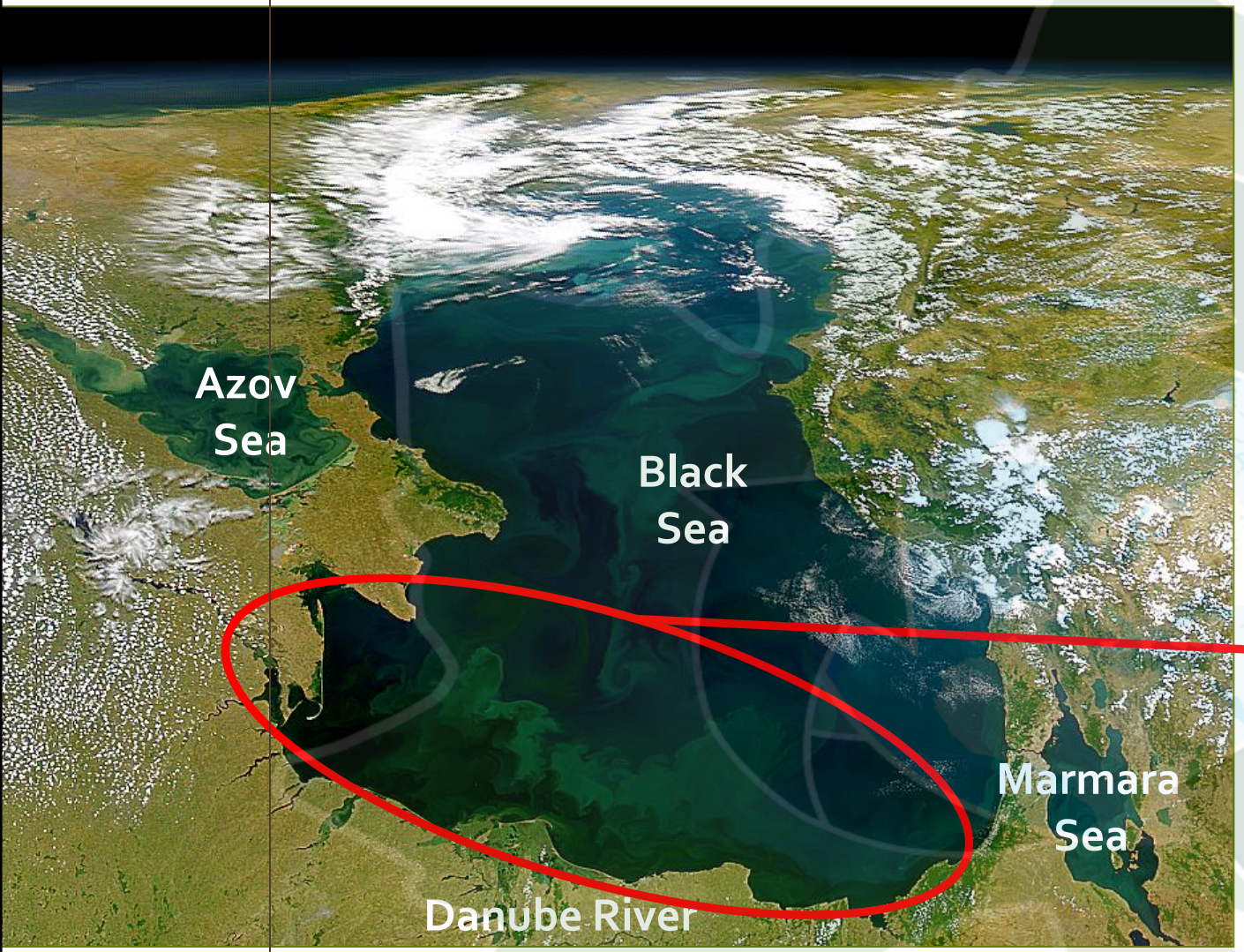
- Appears due to large amounts of fertilisers and pesticides to sustain high crop yields.
- Causes:

❖ increasing of planktonic primary productivity;

❖ transparency decreasing;

❖ hypoxic events;

❖ change of biological state.



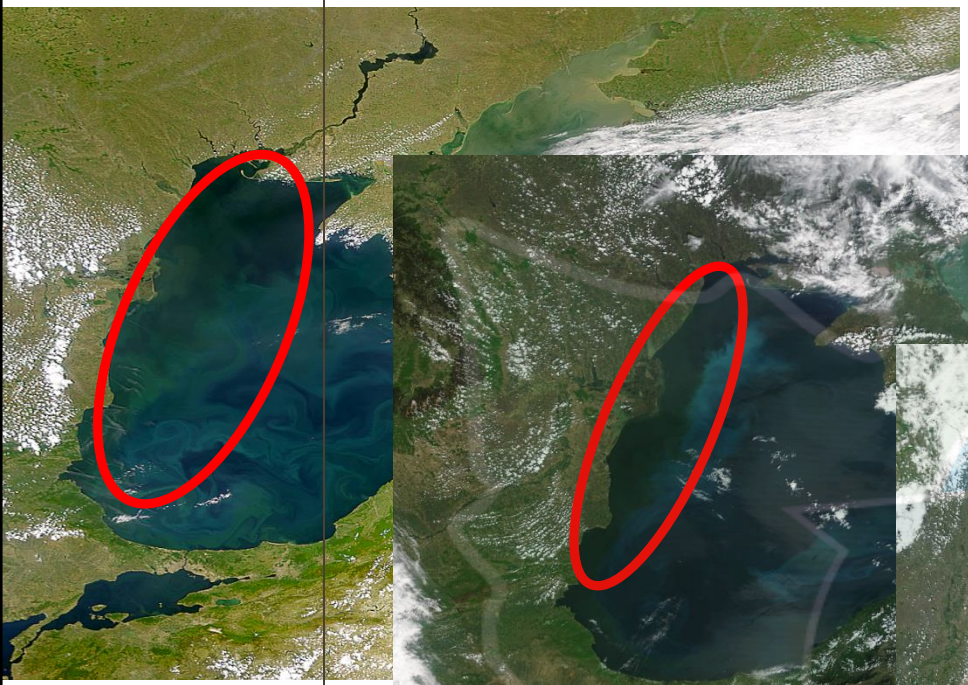
Black Sea satellite image, 1999

NASA/Goddard Space Flight Center, SeaWiFS Project

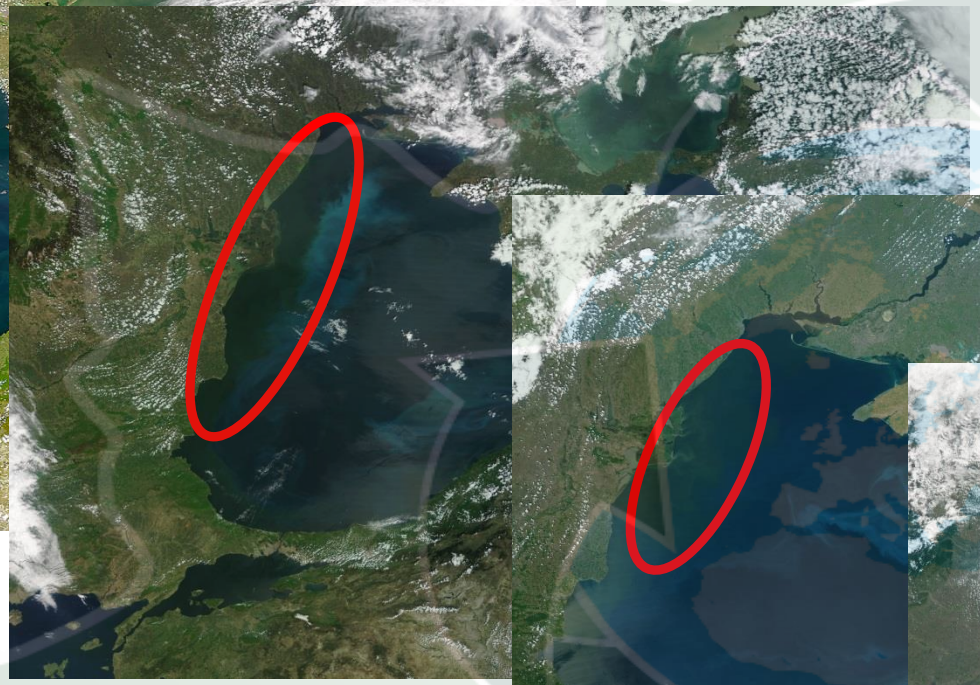
EUTROPHICATION

Between 1973 and 1990 lead to:
- ecosystem endanger → lose of primary functions
- fish deaths (five million tones) → influence sustainable development
- tourism decrease → influence economy and society

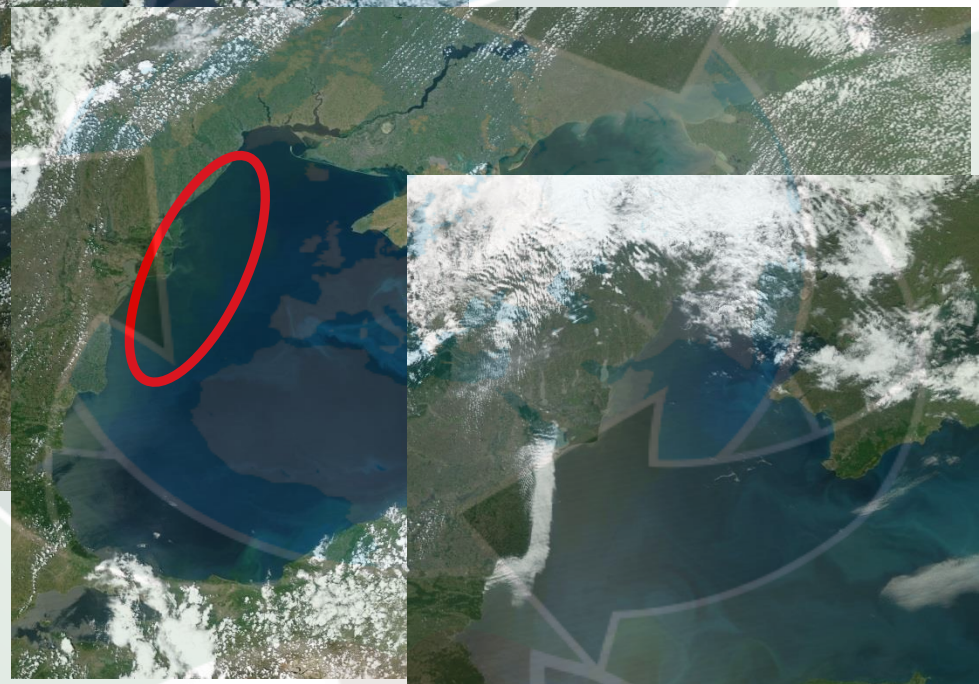
Satellite images of Black Sea, NASA



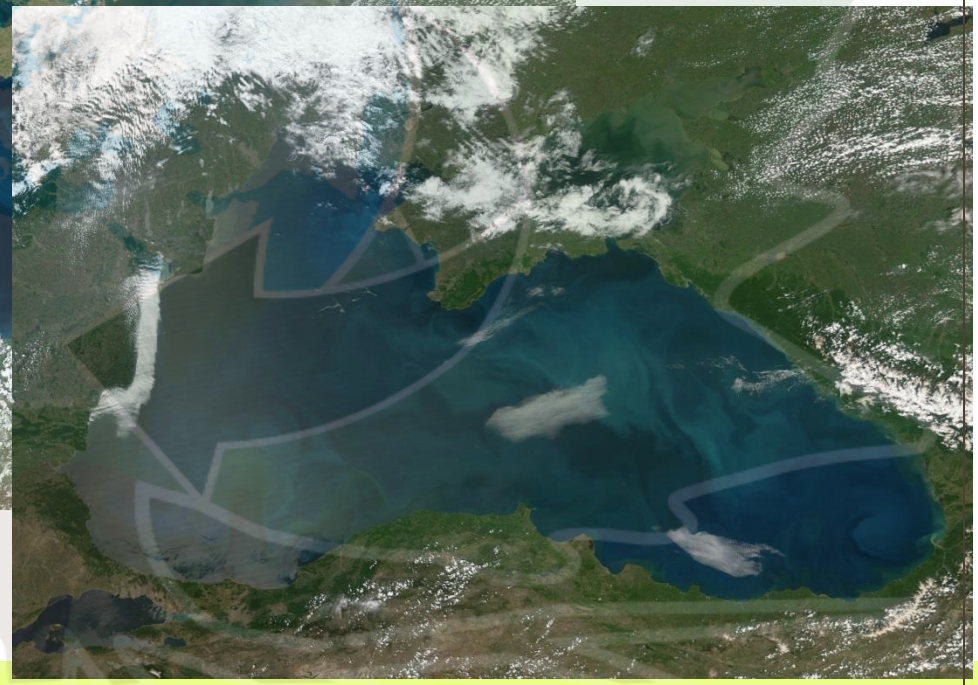
May 2000



May, 2002

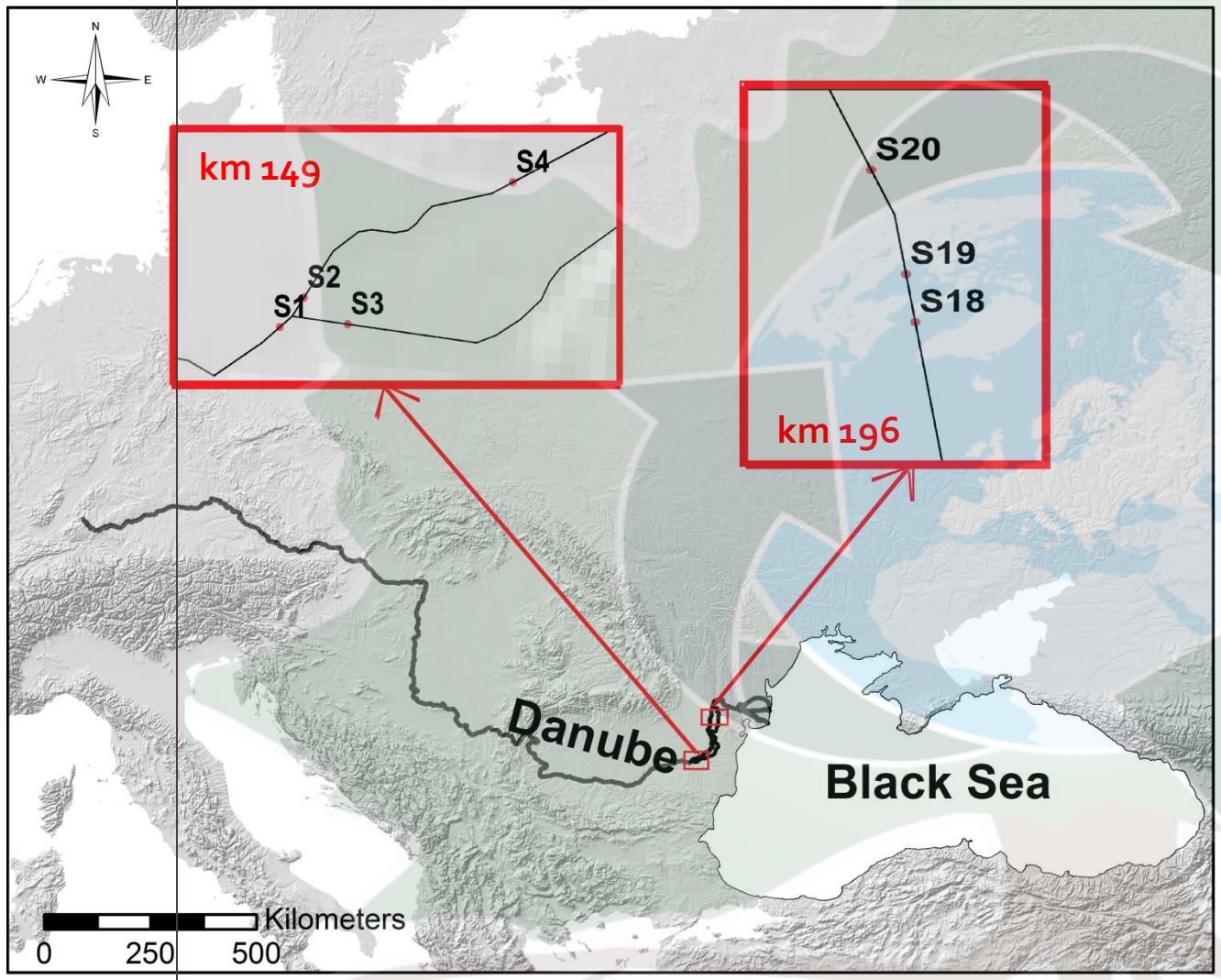


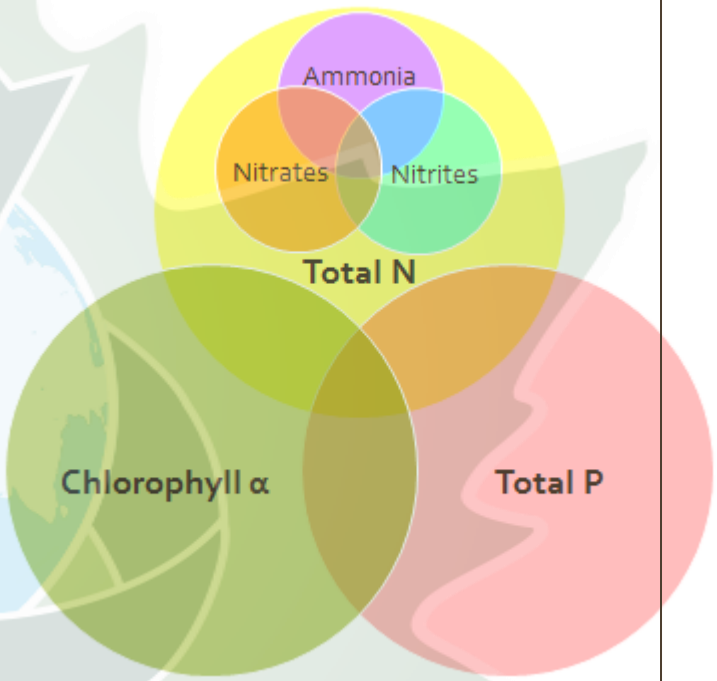
May, 2004



May, 2006

Project "Monitoring the environmental impact of the works regarding the improvement of the navigation conditions on the Danube River between Călăraşi and Brăila, km 375 and km 175"





June, July, August 2012

Results and discussion

Redfield ratio (1934)

N:P = 16:1

Table 1: N/P ratio in water km 149

km 149			
Sampling point	Month		
	Jun	Jul	Aug
1L	8.4	11.9	8.4
1C	16.3	**16.1**	9.9
1R	**17.7**	15.4	10.3
2L	12.2	10.3	11.7
2C	15.1	12.5	10.3
2R	11.8	10.7	10.4
3L	**16.0**	15.1	12.1
3C	11.8	15.6	10.3
3R	10.8	**20.2**	13.8
4L	6.9	10.0	15.8
4C	13.2	8.6	10.4
4R	**22.9**	**19.3**	10.1

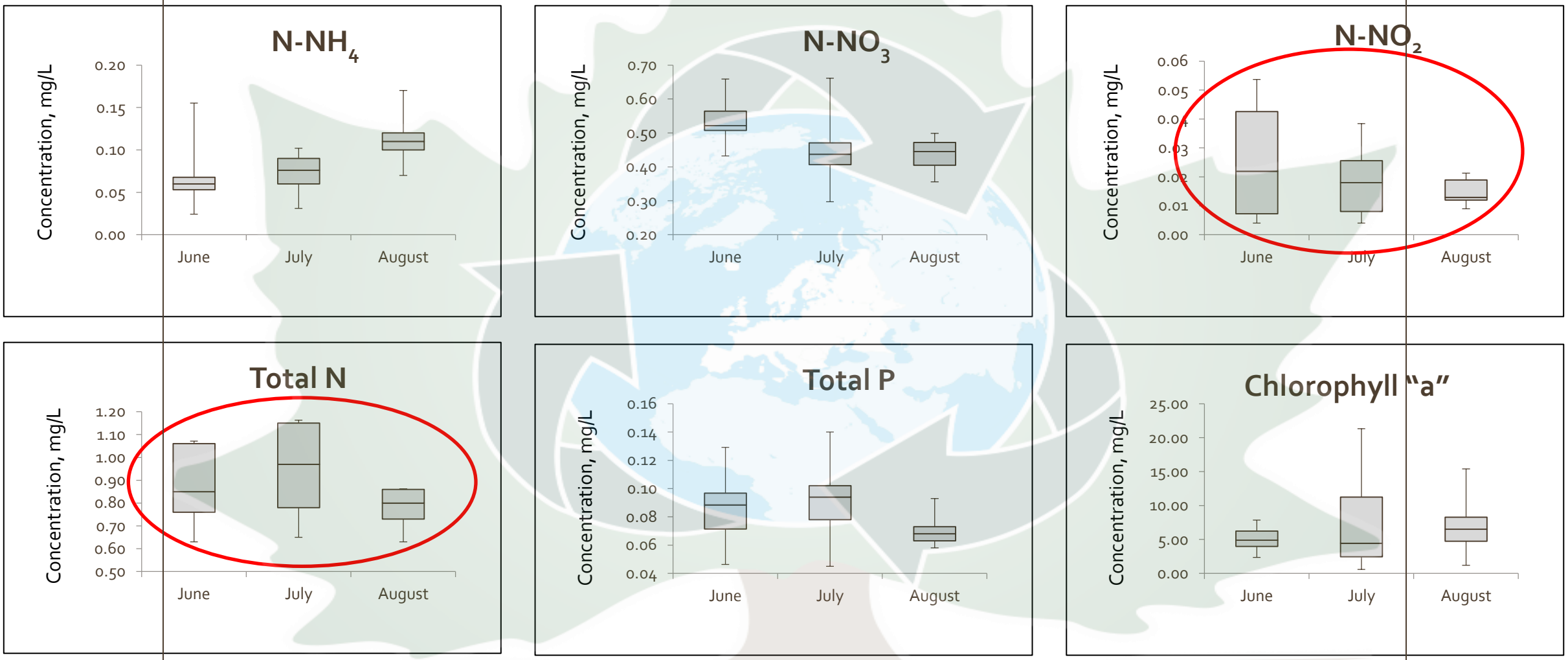
Table 2:N/P ratio in water at km 196

km 196			
Sampling point	Month		
	Jun	Jul	Aug
18L	5.5	**16.3**	15.4
18C	7.8	7.3	15.6
18R	6.9	8.0	11.8
19L	7.3	7.1	13.8
19C	6.3	7.7	13.4
19R	8.3	10.1	11.0
20L	9.3	8.4	11.4
20C	8.6	6.4	13.9
20R	9.5	5.5	8.9

L – left , C – center, R – right

Results and discussion

Figures 1-6: Statistical distribution of nutrients and Chlorophyll "a"



Results and discussion

According to Dodds (1998) the total N concentrations in streams could help in assessing water quality.

Table 3: Percentages of total N values which give indications on water trophic state

	Total N
Oligotrophic	<700, mg/m^3
	11 %
Mesotrophic	700-1500 , mg/m^3
	89 %
Eutrophic	>1500, mg/m^3
	0 %

TRIX index

- introduced in 1998 (by Vollenweider) and improved in 2004;
- EEA considers that the index scale should be developed at regional level;

$$TRIX = \frac{[\log_{10}(Chl\ \text{“a”} * D\%O * N * P) * 1.5]}{1.2}$$

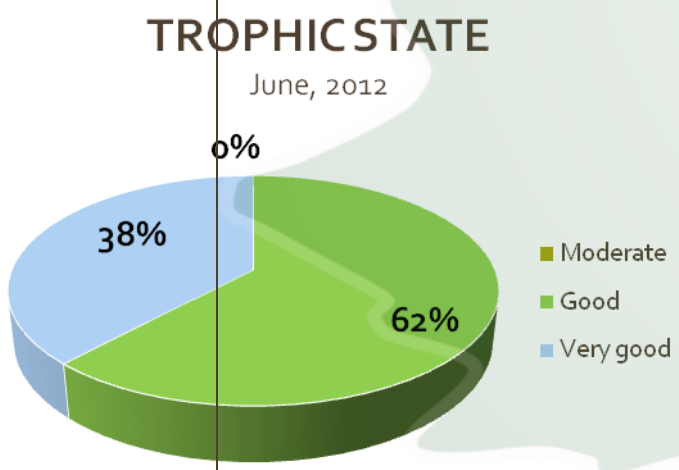
- ❖ Chl “a” = chlorphyll “a”;
- ❖ D%O = oxygen as an absolute deviation from saturation;
- ❖ N = dissolved inorganic nitrogen ($N\text{-}NO_2 + N\text{-}NO_3 + N\text{-}NH_4$);
- ❖ P = total phosphorous.

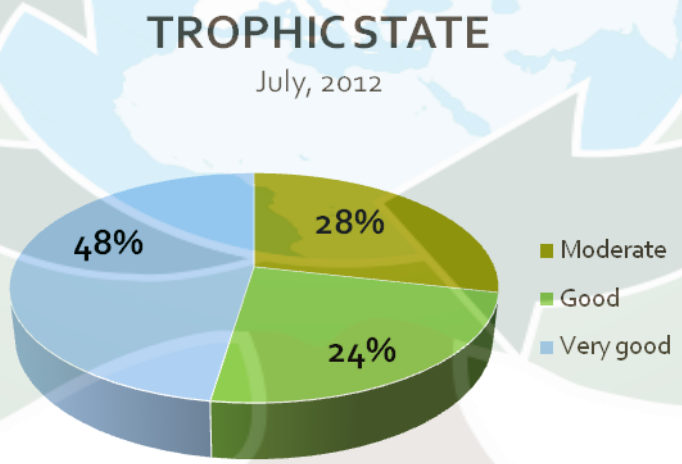
- was scaled from 0 to 10
  - ❖ 0-4 = high quality and low trophic level;
  - ❖ 4-5 = good quality and moderate trophic level;
  - ❖ 5-6 = moderate quality and high trophic level;
  - ❖ 6-10 = degraded and very high trophic level.

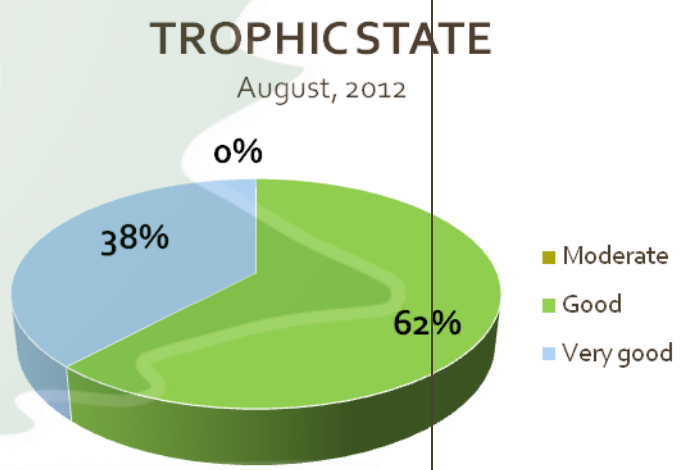
Results and discussion

Table 4: Calculated TRIX index and the associated trophic state of Danube River

	Month	1			2			3			4			18			19			20		
		Left	Center	Right	Left	Center	Right	Left	Center	Right	Left	Center	Right	Left	Center	Right	Left	Center	Right	Left	Center	Right
TRIX Index	June	4.5	4.3	4.3	4.4	4.4	3.9	3.9	4.2	4.2	3.9	4.3	3.5	4.1	4.3	3.4	4.5	4.4	3.6	3.7	4.0	3.7
	July	5.5	5.6	5.3	5.0	4.8	5.1	4.8	5.0	4.9	3.8	4.9	2.7	3.8	4.1	3.9	2.5	3.6	3.3	3.4	3.3	3.9
	August	4.7	4.6	4.1	4.5	4.3	4.0	4.2	4.2	4.1	4.3	4.4	4.2	4.1	2.8	3.7	3.6	3.7	3.5	3.9	3.9	3.9
Trophic state	June	G	G	G	G	G	VG	VG	G	G	VG	G	VG	G	G	VG	G	G	VG	VG	G	VG
	July	M	M	M	M	G	M	G	M	G	VG	G	VG	VG	G	VG	VG	VG	VG	VG	VG	VG
	August	G	G	G	G	G	G	G	G	G	G	G	G	G	VG	VG	VG	VG	VG	VG	VG	VG







Conclusion

- Danube River has a large contribution to the total nutrients load in Black Sea and, hence can have a serious impact on eutrophication phenomenon.

-Level of nutrients load in Black Sea decreased visible after 1999.

- According to Dodds (1998) classification, most of the analyzed samples showed that Danube water revealed **mesotrophic** behavior.

-The calculated TRIX index showed that Danube River's trophic state in summer months is **very good**, **good** and rarely **moderate**.

-***This study underlines that the Danube River does not pose a significant threat to Black Sea from eutrophication point of view***.

-It was confirmed the observed tendency of restoring the ecological state of Black Sea due to decreasing fertilizer and pesticides use in crop fields corroborated with natural remediation.

References

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Let's keep our water clean!