IWAS Brazil ÁGUA-DF

Water quality of Lake Paranoá -
Toxicologically relevant inorganic traces and sum parameters

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Subproject 5
Water Quality

Final Workshop - Project IWAS ÁGUA DF
Integrated Water Resources Management in Distrito Federal – DF
June 4-6, 2013

Situation, Lake Paranoá

http://www.ufz.de/iwas-sachsen/index.php?en=18049

- used for recreational activities, energy generation, fishery, and as receiving reservoir for effluents of two sewage treatment plants (tertiary treat.)
- political decision to use Lake Paranoá as future drinking water reservoir
- few data available concerning basic parameters of the water quality
- lack of information about the occurrence of organic micropollutants in the lake

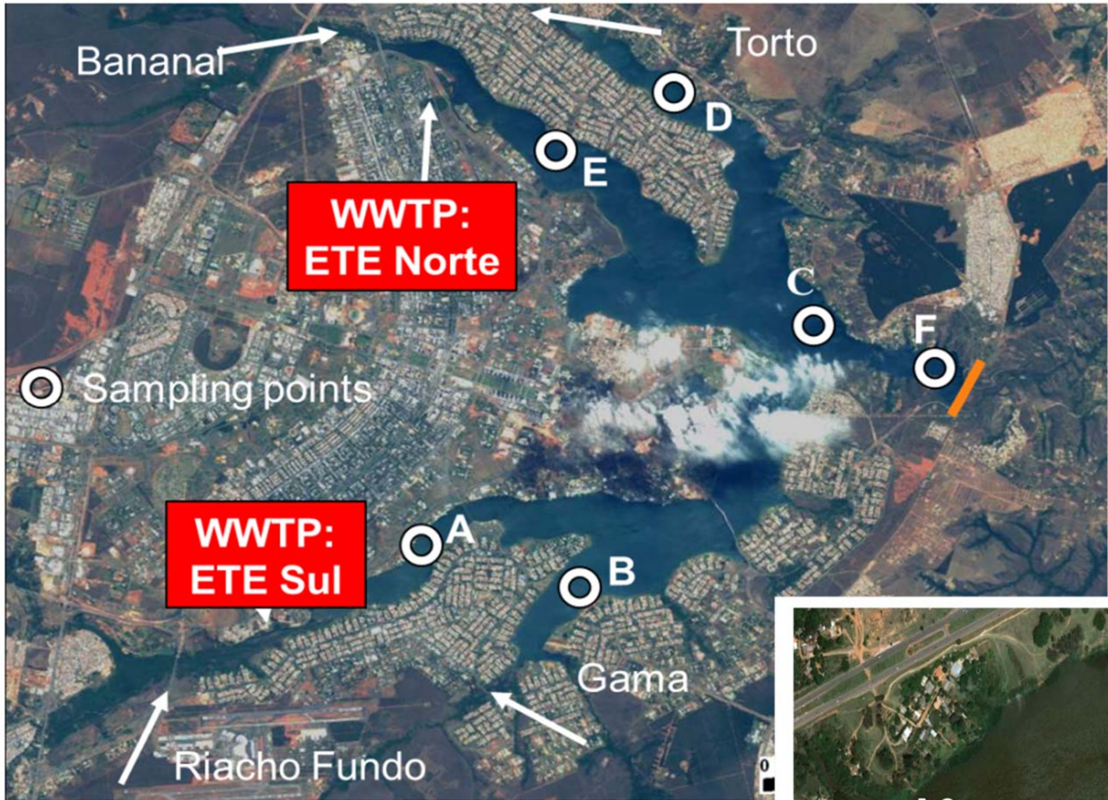
Subproject 5 – Water Quality

Objectives

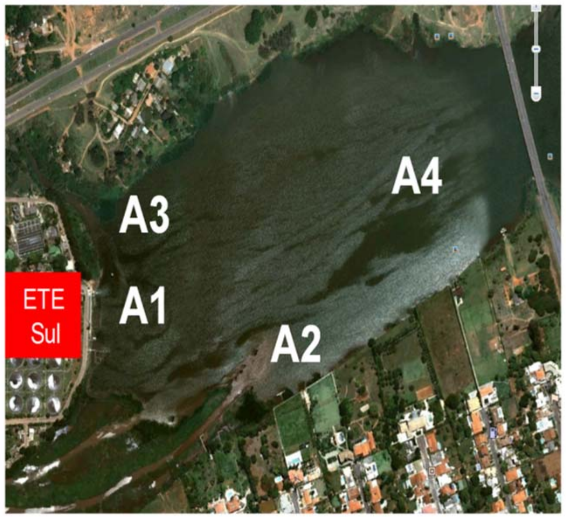
- to gather detailed data and information concerning factors which impact water quality in the Federal District
- to monitor water quality, to specify sampling points and sampling campaigns
- to screen contaminants relevant for water quality, including metals, organic sum parameters, and organic micropollutants
- to evaluate data and to look for trends and conclusions for further required water analysis
- to adapt and implement analytical methods in Brasilia (Caesb)

Sampling

Sites selection and strategy



- A to E (Caesb), F (new)
- main tributaries (4)
- effluent WWTP (Norte, Sul)
- grab samples
- 1 m b.s.
- depth profile in C
- sampling during wet and dry season



- daily composite samples (WWTP)
- sediments (A1,2,3,4), porewater

caesb

google earth

Outline, water quality of Lake Paranoá

- **inorganic compounds**
  - anions, phosphorous, (heavy)metals, metalloids
- **DOC, advanced DOC characterization**
  - gel chromatography with online OC- and UV-detection
  - SAK (254 nm)
- **sediments**
  - heavy metals and phosphorous
  - colloids and nanoparticles
- ***organic micropollutants*** *(⟶ WG Worch et al.)*

Basic inorganic parameters, Lake Paranoá (A-F)

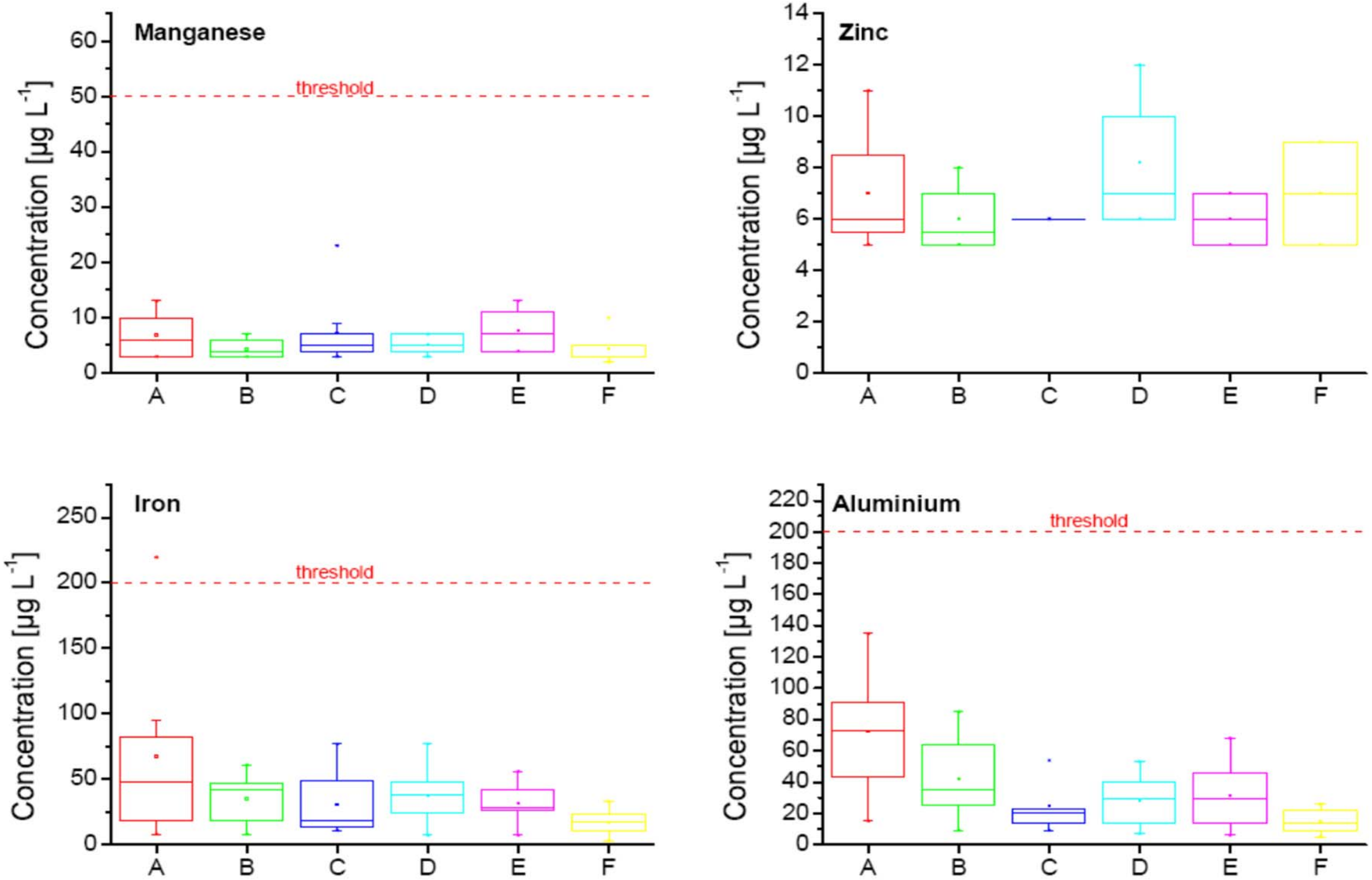
pH	Elect. Cond. μScm^{-1}	Cl^- mgL^{-1}	NO_3^- mgL^{-1}	P μgL^{-1}	SO_4^{2-} mgL^{-1}	Ca^{2+} mgL^{-1}	Mg^{2+} mgL^{-1}
7.5...8.0	80 ... 110	6 ... 8	2 ... 7	22 (m)	6 ... 10	8.82 (m)	0.99 (m)

Metals, As, B, Se, Si conc. (mean val. (m)), Lake Paranoá (A-F)

	Al	As	B	Cd	Cr	Cu	Fe	Mn	Na	Ni	Pb	Se	Si	Zn
μgL^{-1}	34	< 10*	11	< 2	< 2	< 10	31	5	8110	< 5	< 10*	< 10*	2750	6
GER	<u>200</u>	10	1000	3	50	2000	<u>200</u>	<u>50</u>	<u>$2x10^5$</u>	20	10	10	-	<u>5000</u>
BRA	200	10	-	5	50	2000	300	100	$2x10^5$	70	10	10	-	5000

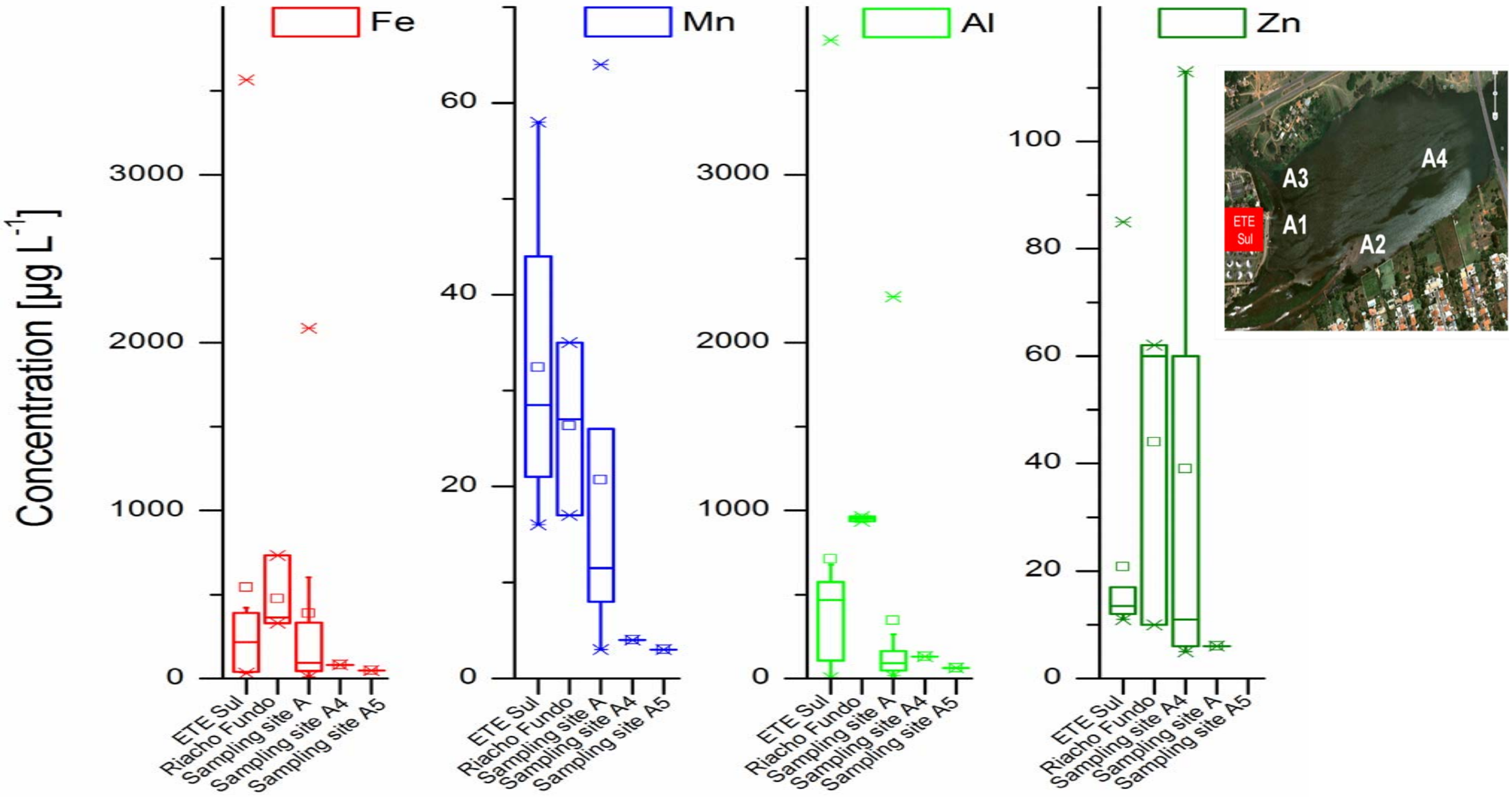
Jul`10 to Feb`13; n = 70 per metal, n = 11 per site
threshold value for drinking water (GER, BRA), <u>indicator value, WHO (Zn)</u>, *ICP-MS

Metal concentrations, spatial distribution



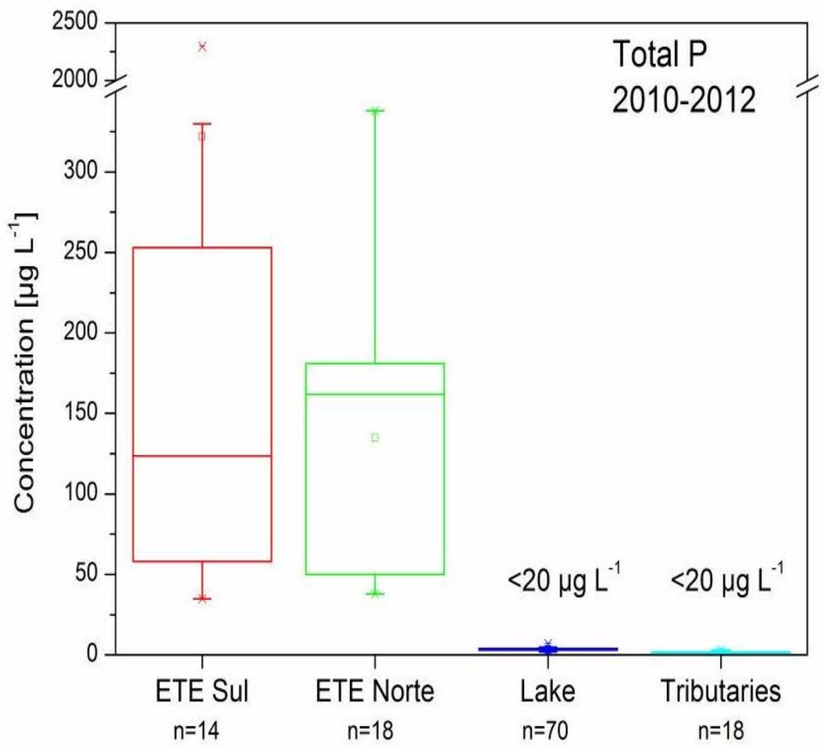
sampling sites A (n = 10), B (n = 10), C (n = 10), D (n = 10), E (n = 8) and F (n = 8) during May, July, September and November 2011; threshold indicates the German drinking water threshold

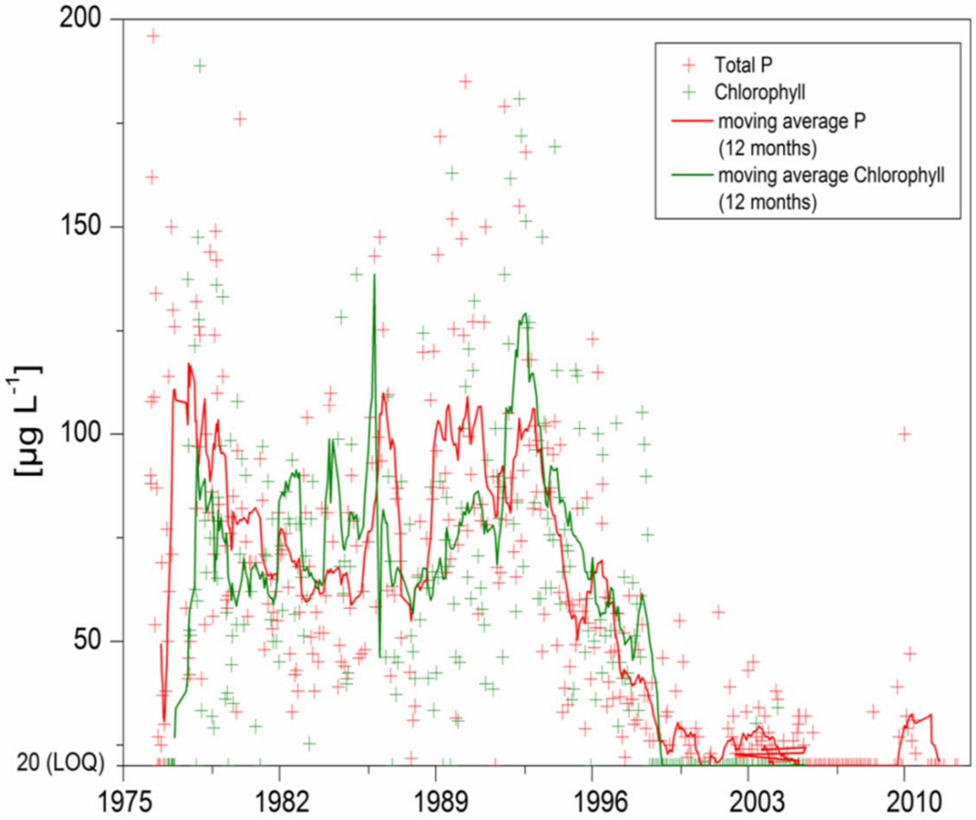
Discharge from WWTP and tributaries



effluent WWTP ETE Sul (n = 11), Riacho Fundo (n = 4), from Dec. 11 to March 12, A (n = 10), A4 (n = 1) und A5 (n = 1)

Phosphorous, discharge from WWTP and tributaries

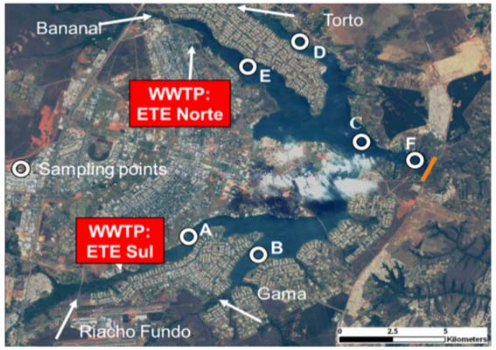


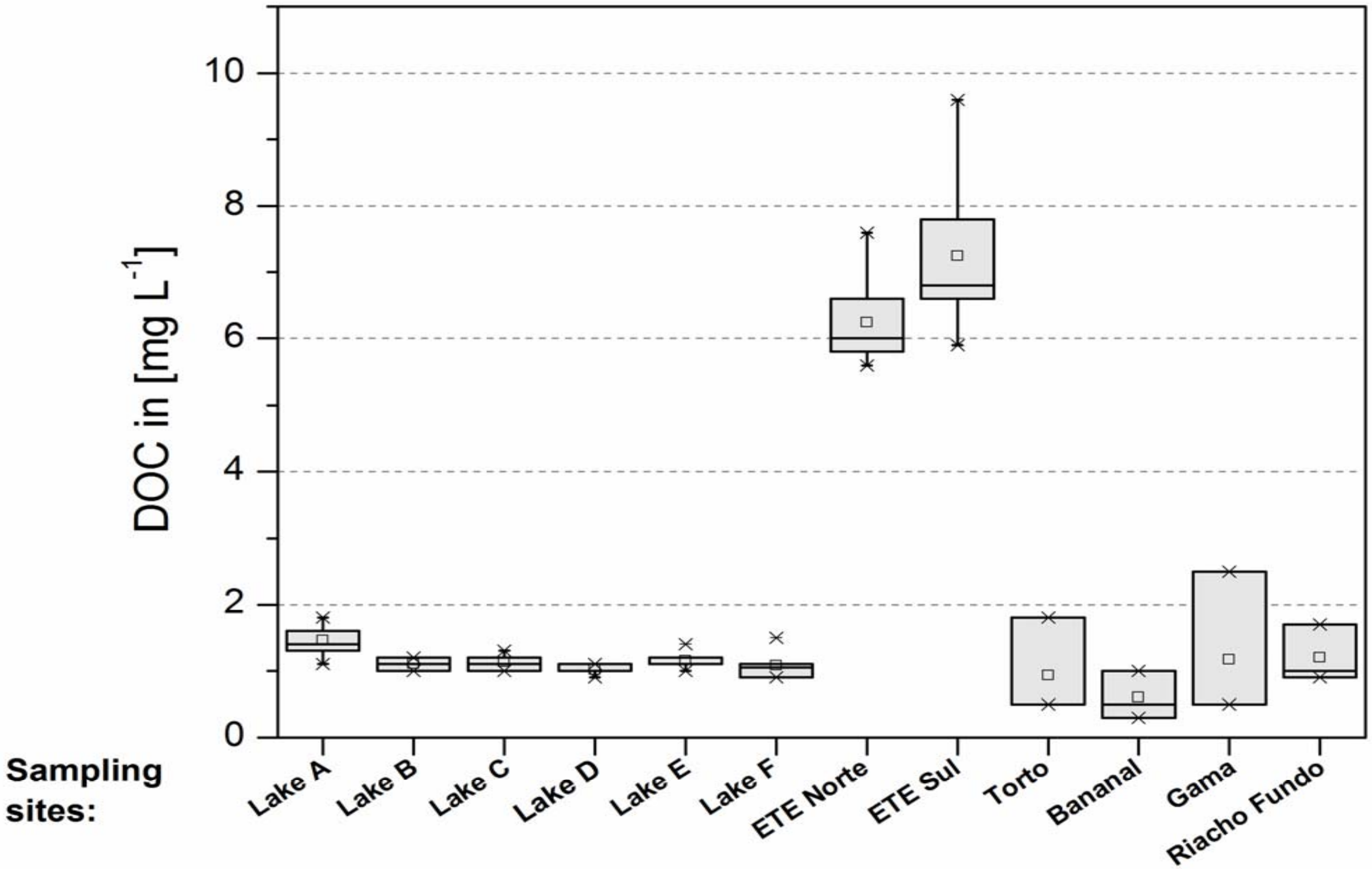


caesb

Dissolved organic carbon (DOC)

Natural organic matter (NOM), humic substances (HS)

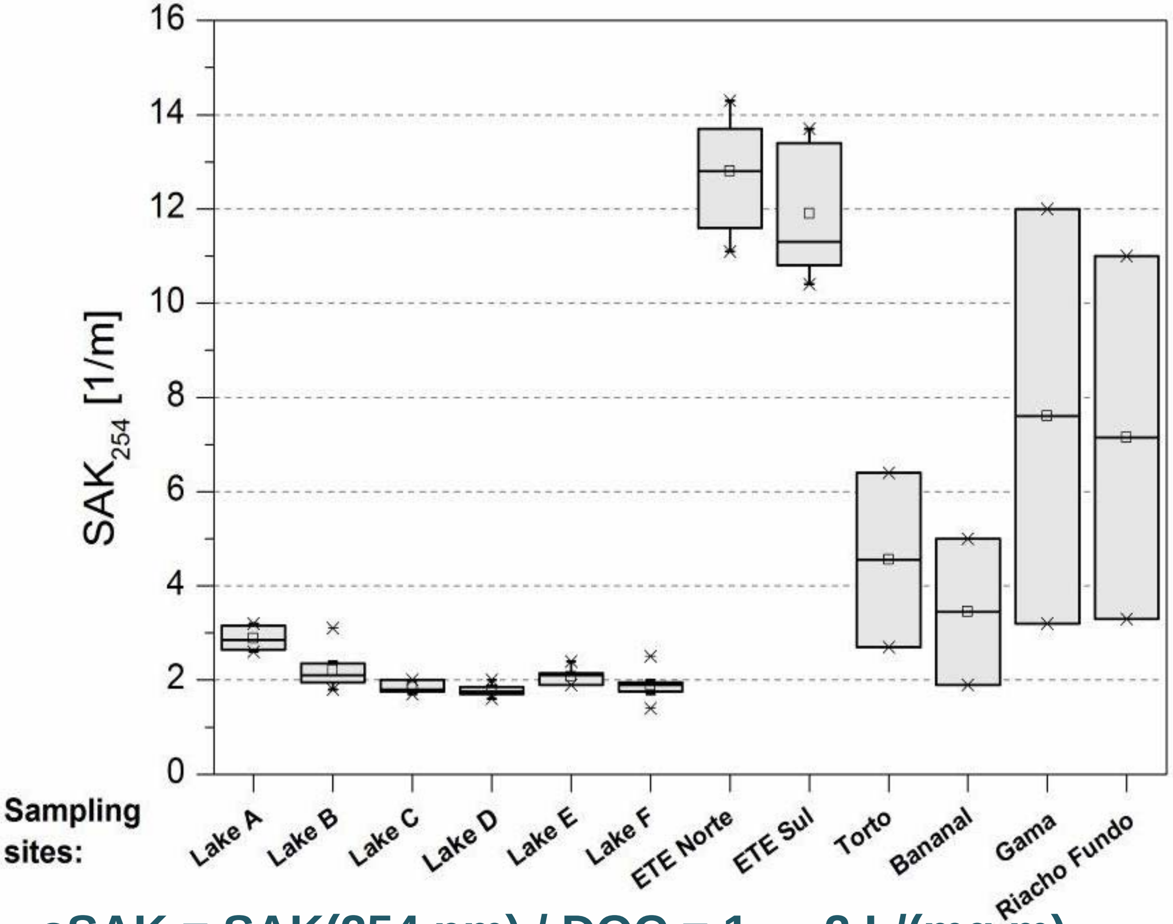


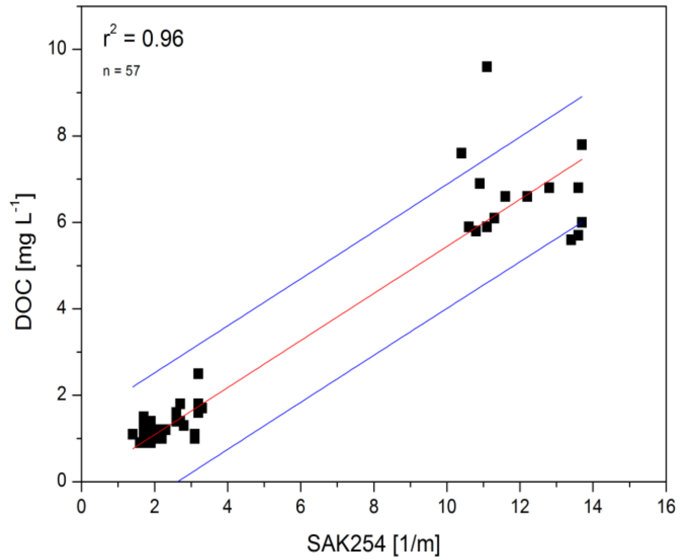


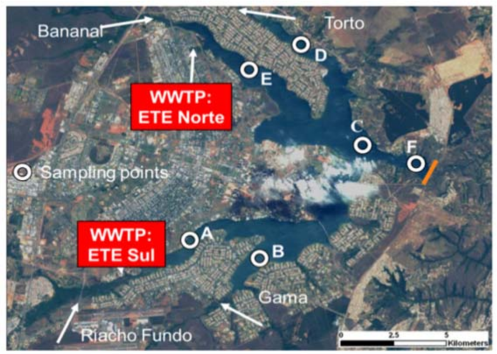
A to F (n = 6 per site), WWTP effluents (n = 6 ETE Sul, n = 4 ETE Norte) and in the tributaries (n = 3); data from 2010 to 2013.

Spectral Absorbance at λ = 254 nm

indication for unsaturated bonds, lone pair electrons, and/or aromatic structures

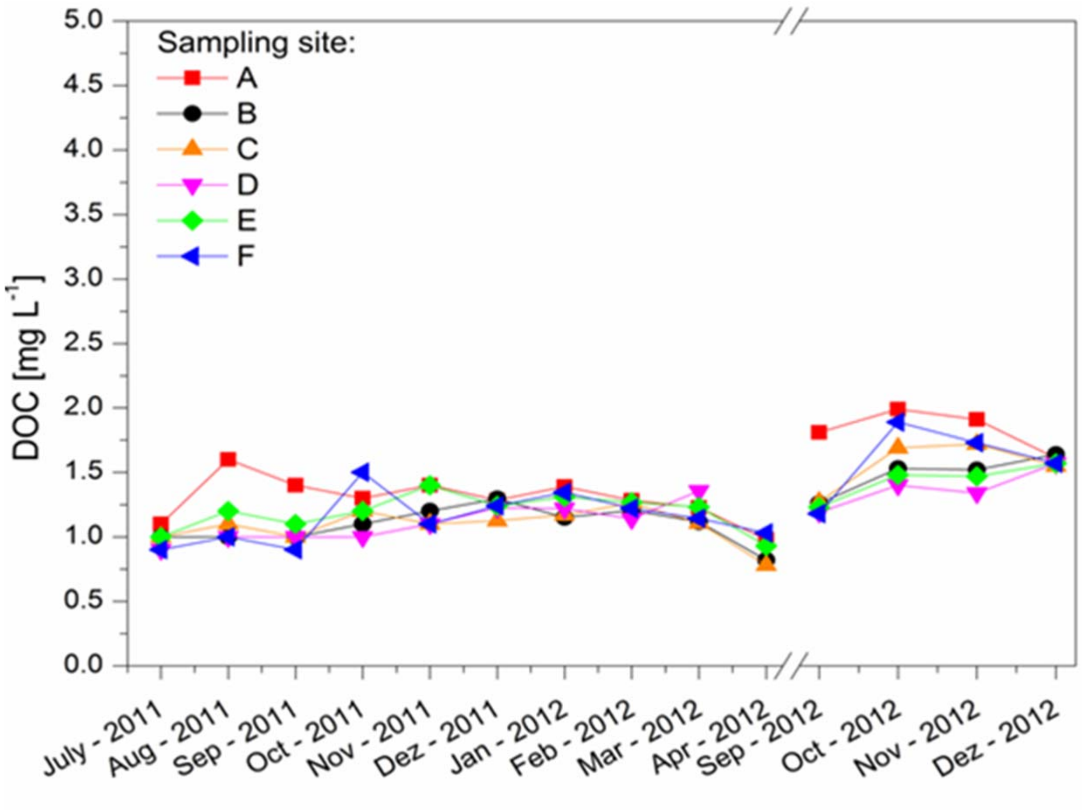


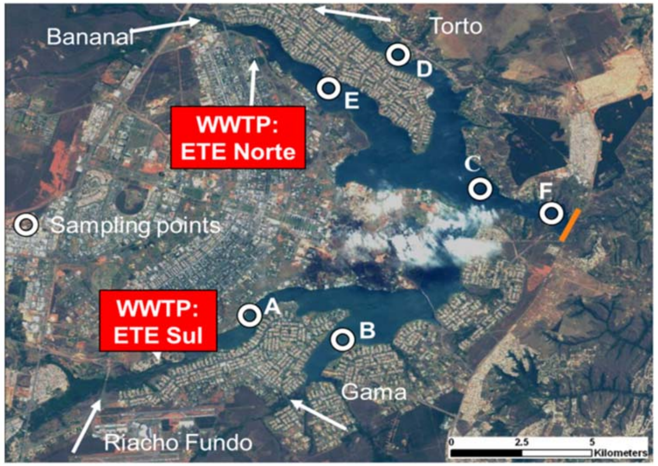


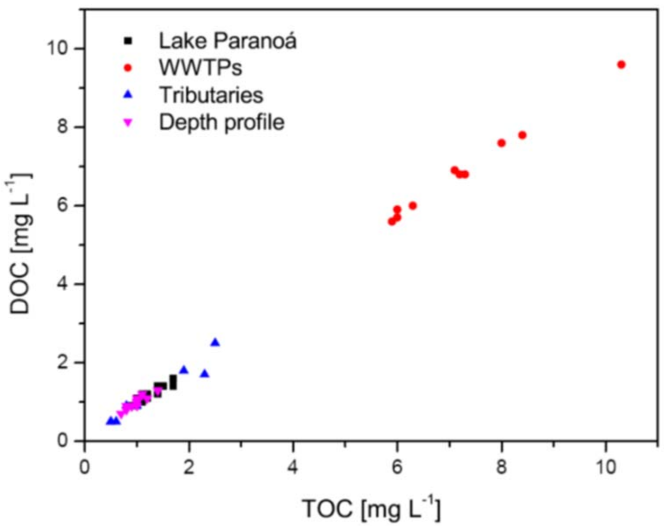


sSAK = SAK(254 nm) / DOC = 1 … 2 L/(mg m)

DOC, season



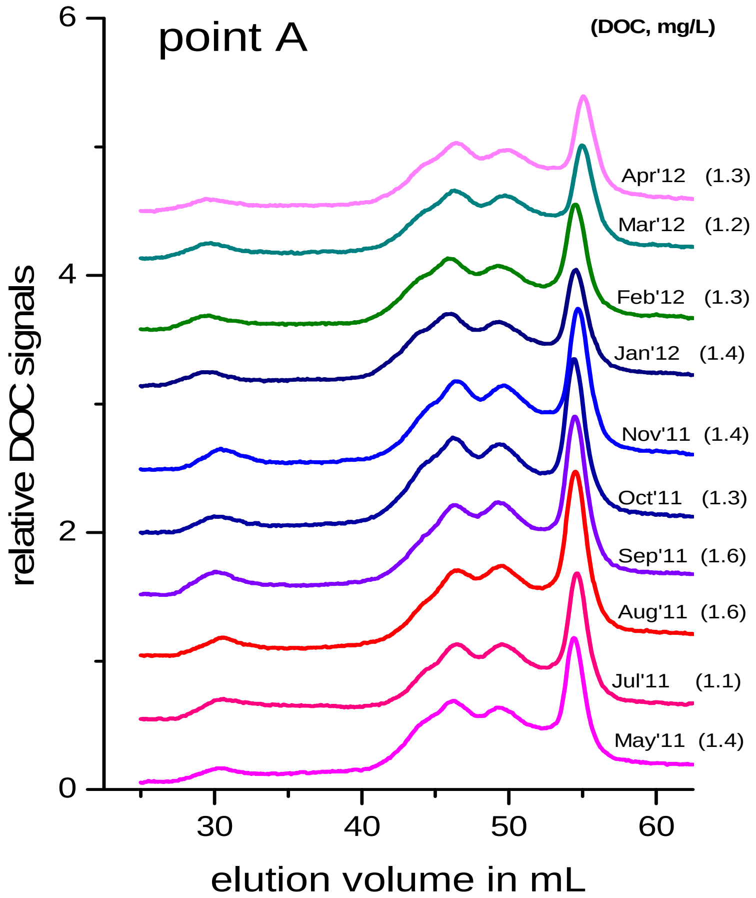


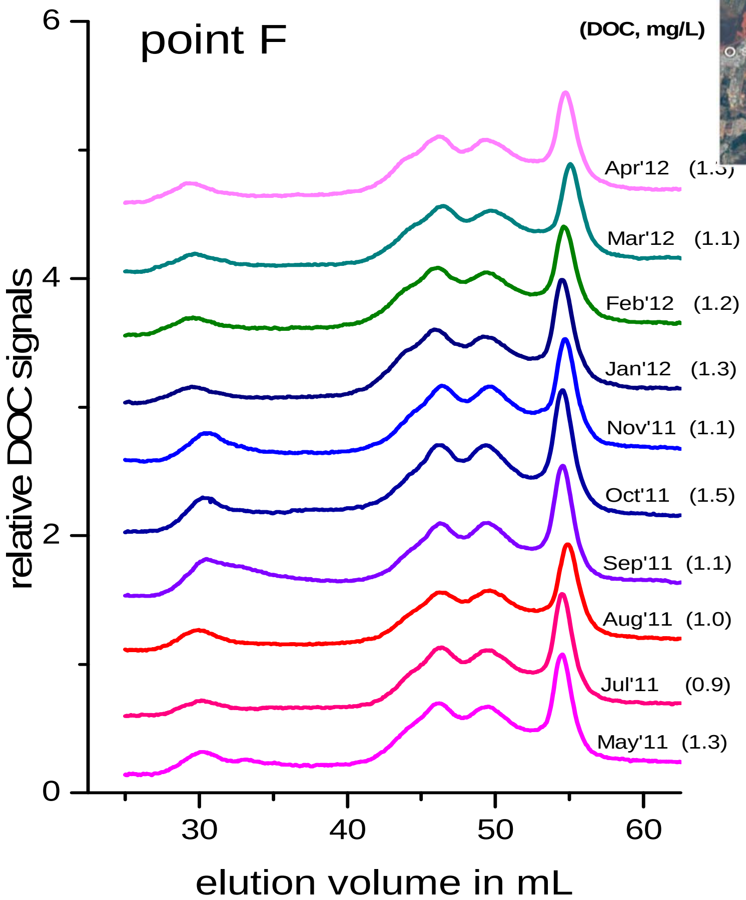


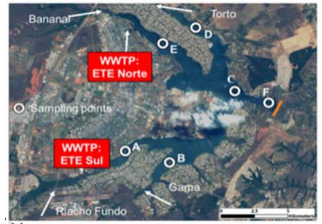
- low variation in depth
- low particulate fraction (POC), (lake, WWTP, tributaries)

DOC – character, seasonal and spatial distribution, I

Size Exclusion Chromatography, online OC- and UV- detection



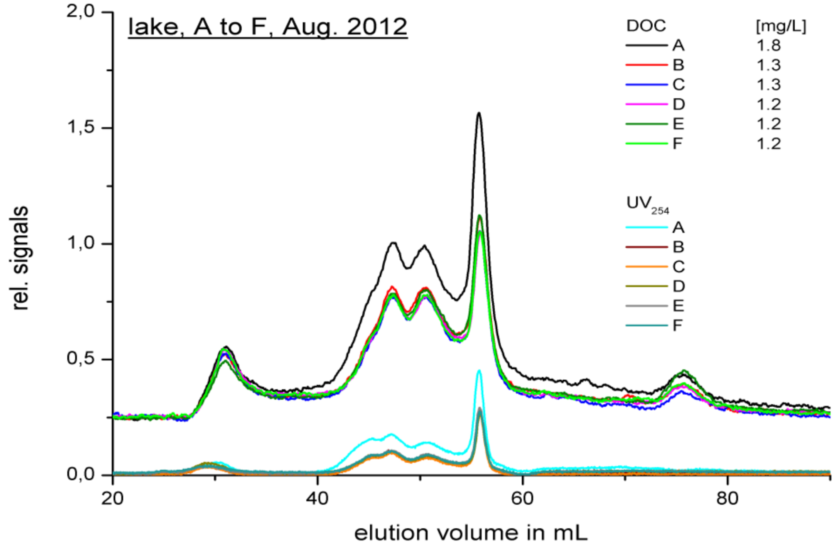


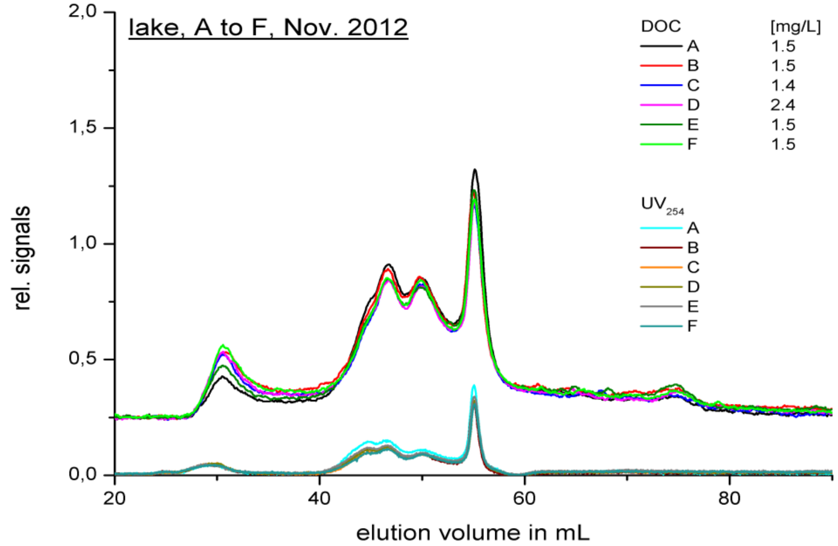


low variation in season: the molecular weight distribution of the DOC in the lake is very similar (A, F), no big difference between May´11 to April´12

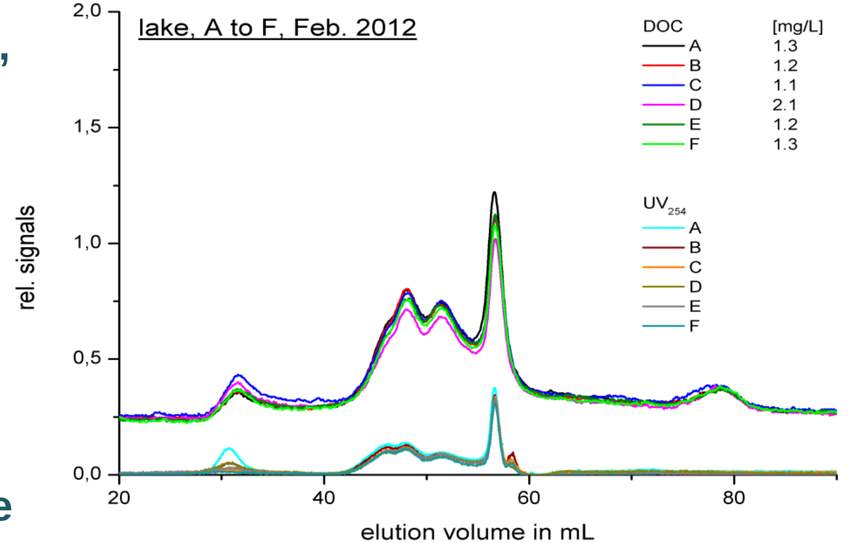
DOC – character, seasonal and spatial distribution, II

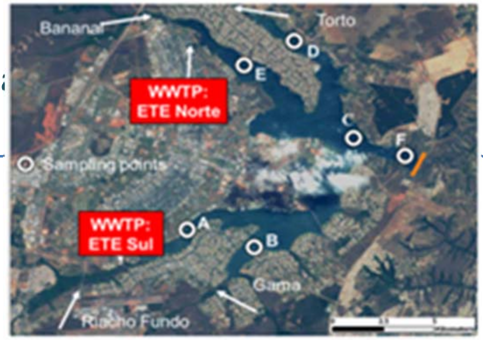
SEC online OC- and UV- detection





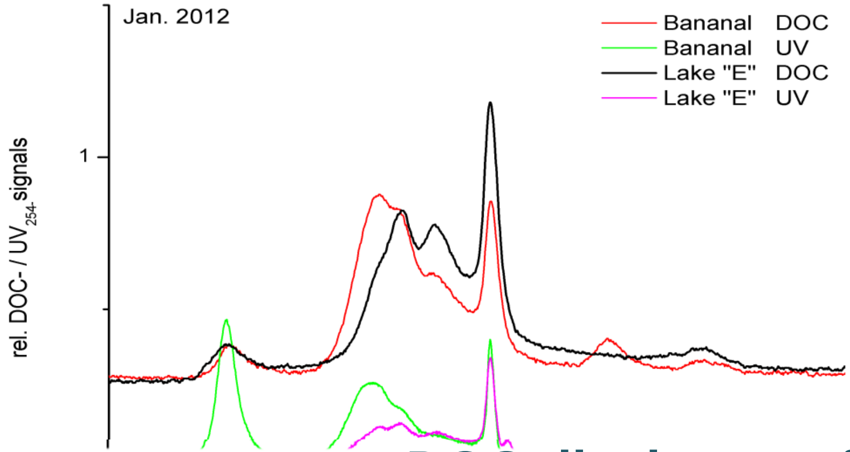
- **low amount of high molecular weight subst., most subst. belong to a MW between 4000 and 400 g/mol (PEG), showing aromatic and unsaturated functional groups**
- **the molecular weight distribution of the OM in the lake is quite similar (A to F),**
- **low variation in season, and in sampling site**

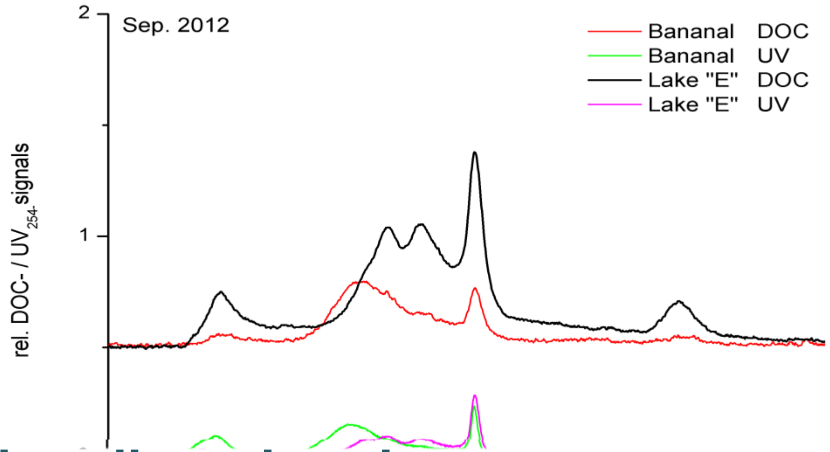




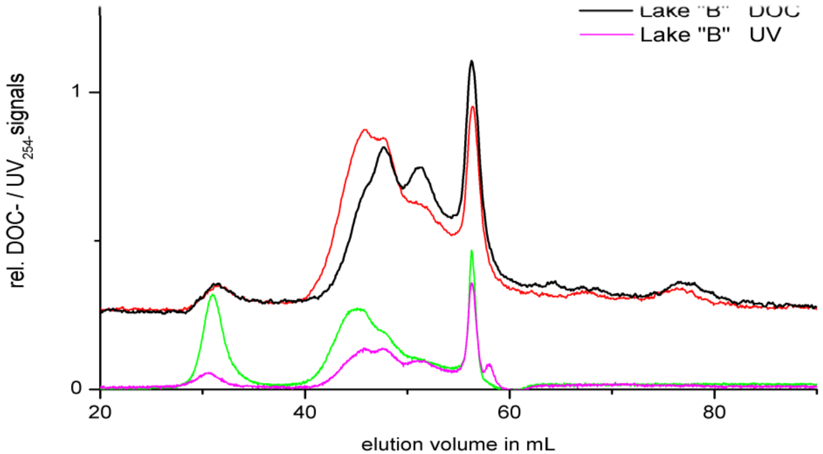
DOC – discharge of tributaries

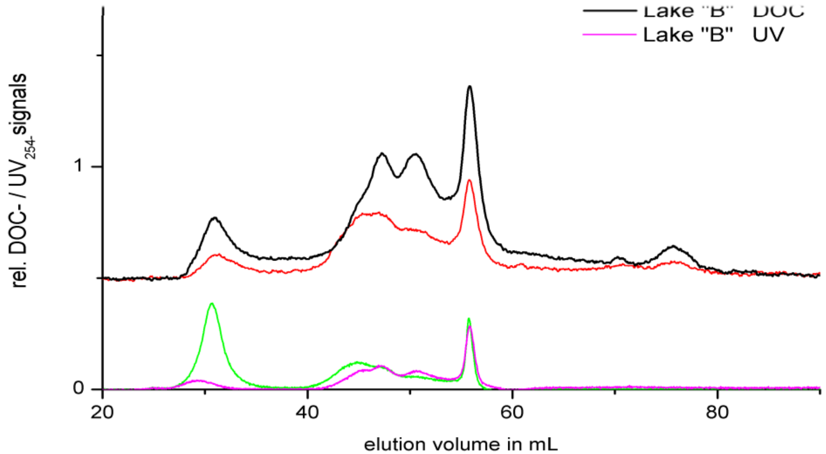
SEC online OC, UV detection





DOC discharge of the tributaries shows higher molecular weight distribution





Sediments

Geoaccumulation index I_{Geo} (Müller 1986), clay rock standard

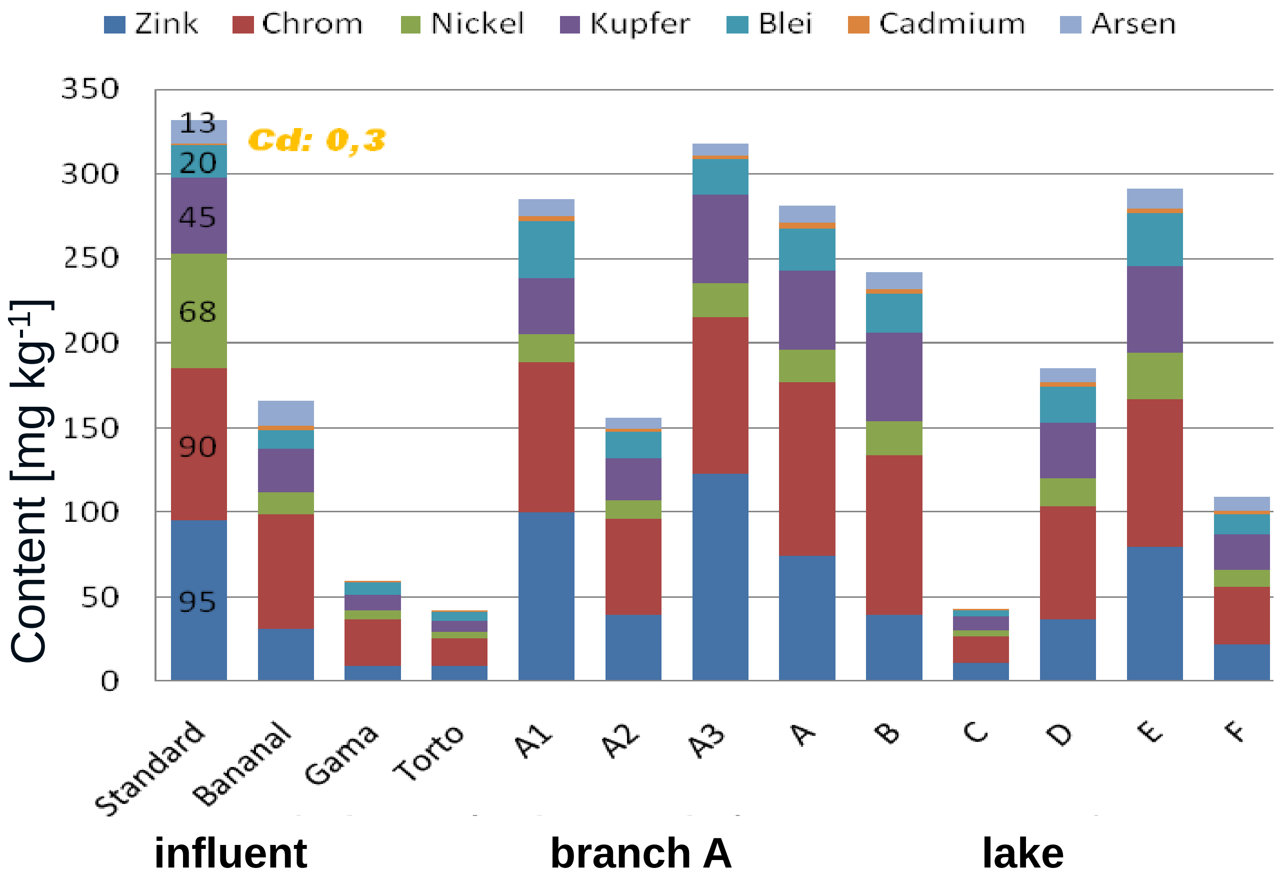
I_{geo} Class		As [mg/kg]	Cd [mg/kg]	Pb [mg/kg]
	Background	13	0,3	20
0	Not polluted	19,5	0,45	30
1	Not polluted to moderadly polluted	39	0,9	60
2	Moderadly polluted	78	1,8	120
3	Moderadly polluted to strongly polluted	156	3,6	240
4	Strongly polluted	312	7,2	480
5	Strongly polluted to very stong polluted	624	14,4	960
6	Very strong polluted	1248	28,8	1920

$$I_{geo} = \log \frac{C_n}{1{,}5 \cdot B_a}$$

C_n concentration in the sediment (in mg/kg)

B_a natural background (from silt-standard) (in mg/kg)

Sediments, heavy metals



class 0

not polluted

not for

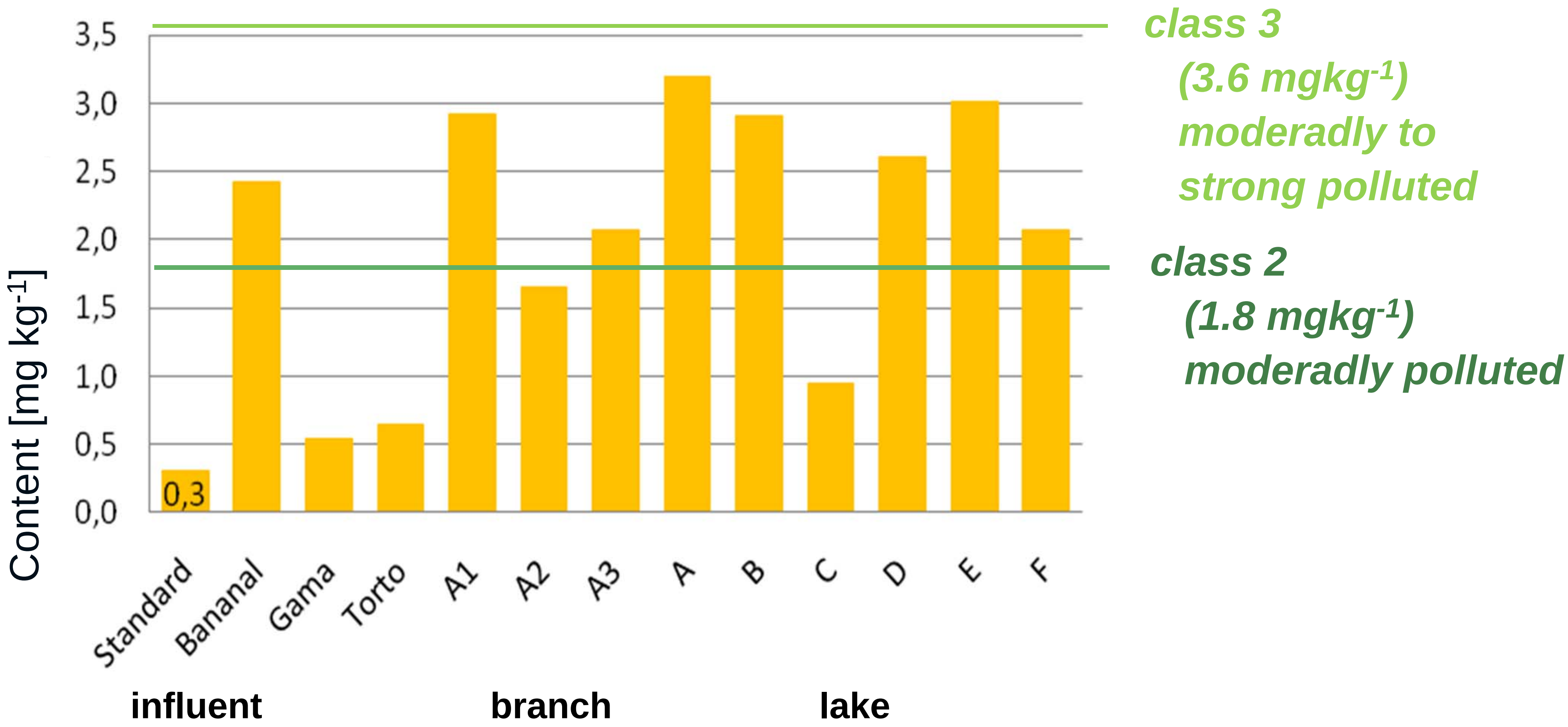
Pb, Cd

Pb: A1, E
class 1

not polluted to moderadly polluted

- **sampling during Dec´11 and Jan´12**
- **digestion of dried sediments with H_2SO_4/HNO_3, analysis by ICP/OES**

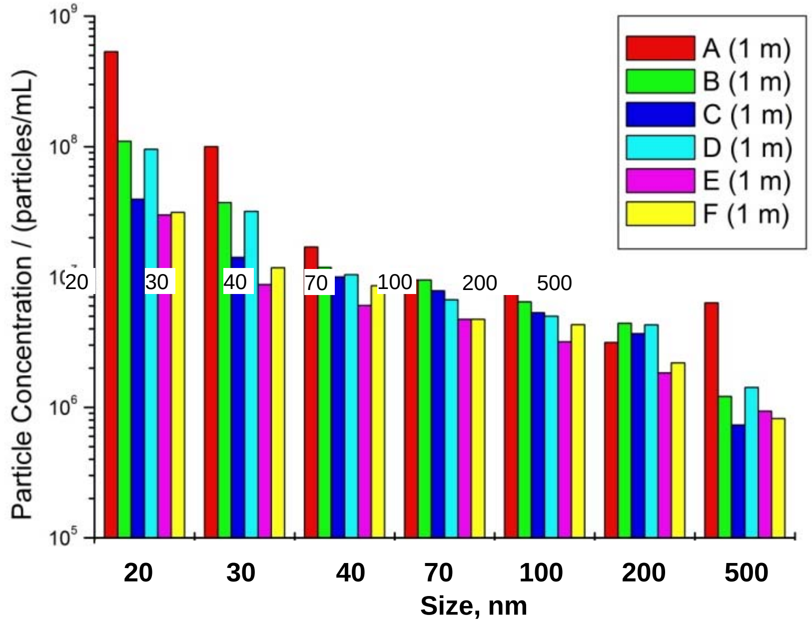
Sediments, Cadmium

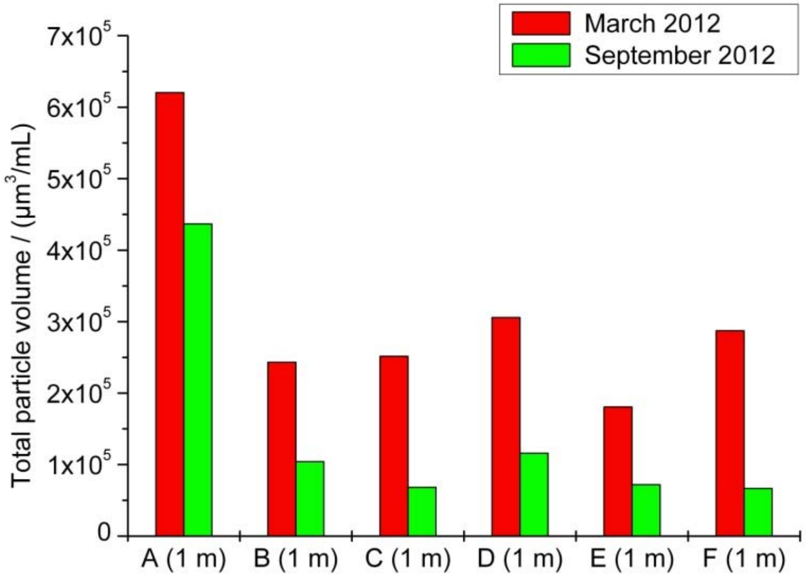


- sampling during Dec´11 and Jan´12
- digestion of dried sediments with H_2SO_4/HNO_3, analysis by ICP/OES

Colloids and Nanoparticles – TZW, Tröster

LIBD (Laser Induced Breakdown Detection)





Particle size distribution

- **concentrations up to 1.8*10^9 particles/mL (sampling point A, 20 nm, March´12)**
- **pareto-like size distributions for A to F**
- **high number conc. of particles < 100 nm**

Spatial distribution in the lake

- **highest concentrations at sampling point A**
- **temporal variations (rainfall period)**
- **sampling point F concentrations within the lowest range**

Summary and Conclusions

- low variation during measuring periods (lake)
- significant impact of the WWTP and the tributaries

Inorganic basic parameters

- the two WWTP effluents are significantly higher for Al, B, Zn; different pattern in the tributaries

Organic sum parameters (DOC, SAK)

- low DOC: 1 – 2 mg L^{-1}; WWTP effl. DOC: 5 to 10 mg L^{-1}, higher variation and higher DOC in the tributaries
- similar molecular weight distribution (MWD), tributaries higher MWD

Sediments

- good sediment quality (class O, not polluted rainy season, grab sample); not valid for Cd, Pb and total P (not shown)
- Phosphorous bound in the particulate fraction (pore water, aqueous extracts, not shown)

- the raw water reaches almost all drinking water shreshold numbers (inorganic parameters)
- low DOC (flocculation, low THM FP)

Acknowledgements

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