Decrease of surface-active substances (SAS) concentration during last decade in the northern Adriatic Sea

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SAS in seawater

- molecules with hidrophobic part:
  - lipids – ~ 3 %,
  - proteins – 13-44 %,
  - humic substances – up to 50 % sea OM

- high molecular weight molecules: 25-35 % sea OM
  - hidrophilic polysaccharides
The main source of SAS....

....is autochthonous phytoplankton production
Determination of SAS concentration and acidity

By electrochemical measurements by using o-nitrophenol as a probe

Fig. 2. o-nitrophenol peaks for increasing adsorption time
Determination of SAS in the northern Adriatic:

- concentration in the range of 0.04 – 0.17 mg/l in equivalent concentration of T-X-100
- relative acidity in the range of 0 – 40 l/mg

Relative acidities of some organics substances:

BIOGENIC OM: LIPID: linolic acid - 1 l/mg

POLYSACCHARIDES: Xanthan - 10 l/mg
dextran T-500 - 3 l/mg

PROTEIN: Albumin-15 l/mg

HUMIC SUBSTANCES: fulvic acid - 20 l/mg
humic acid - 25 l/mg
Carbohydrates substantially contribute to the SAS (1), especially in the surface layer

Fig. 5. Relationship between surface-active substances and carbohydrates surface layer at the station 107, data presented for the period 1998-2005 (without 2003 and 2004)

Study site in the northern Adriatic
Annual distribution of SAS

- sinusoidal change of SAS within the period of one year
- decrease with depth

Highest SAS – summer
Lowest SAS – winter

- similar distribution as DOC
Fig. 2. Distribution of SAS for surface layer of station 107 from 1998 to 2010 (without years 2003 and 2004).

Two sample t-test method: at the 0.05 confidence level the difference between the population means for SAS for the periods 1998-2002 and 2005-2010 is significant (p=0.0006676). Period 1998-2002 had 23.4 % higher SAS concentrations than period 2005-2010.
The correlation between SAS and salinity

Fig. 2. Distribution of salinity for surface layer of station 107 from 1998 to 2010 (without years 2003 and 2004).
Fig. 4. The correlation between SAS and salinity, as a measure of new nutrient input.
Two sample t-test method: at the 0.05 confidence level the difference between the population means for the periods 1998-2002 and 2005-2010 are significant for 5 and 10 m depth. Period 1998-2002 had 21.5 % at 5 m and 17.9 % at 10 m higher SAS concentrations than period 2005-2010.
Fig. 4. Salinity variations for the station 107 for the period from 1998 to 2010.
Long-term distribution of SAS acidity

Average relative acidities

1998-2002
Surface – 13
Bottom - 20

2005-2010
Surface – 17
Bottom - 19

These differences for the two investigation periods are consistent with lower contribution of freshly produced less acidic biogenic SAS to the SAS pool in the upper water column in 2005-2010.

Fig. 13. Relative acidity of the SAS in the period from 1998 – 2010, for the surface (red) and bottom (black).
Conclusions

There was reduction of SAS in the last 5 years (although increasing trend since 2005 is observed)

This is explained by the lower SAS production by phytoplankton community and connected to the decrease of land-derived nutrients due to the decreased freshwater discharges (higher salinities).
This is probably because of the shortening of snow cover period in the Italian Alps.

From the literature:
All Mediterranean rivers suffer from a significant reduction in freshwater discharge (Ludwig et al., 2009).

Analyses of trends over 30 years in the northern Adriatic show an increase in salinity and a clear reduction in concentrations of phosphate and ammonia in coastal areas (Solidoro et al., 2009).

The decreasing trend of the Chl $a$ in the Mediterranean Sea is observed and explained by increased nutrient limitation that resulted from reduced vertical mixing due to a more stable stratification, in line with general warming trend of the Mediterranean Sea in the last 25 years (Barale et al., 2008).

Mozetič et al. (2010) published on a global tendency towards Chl $a$ reduction in the Northern Adriatic Sea.
Changes in acidity properties of SAS in the last 5 years came from the lower contribution of biogenic SAS to the SAS pool


Possible changes and consequences in the next future for the ecosystem of the Trieste gulf/Northern Adriatic

From the SAS distribution it is seen that higher SAS were measured during mucilage years.

The SAS distribution in the last 5 years imply on increasing trend.

If such trend continued the system may come to threshold value in SAS concentration that is necessary for appeareance of mucilages.

So, if there will be high rivers runn-off in the northern Adriatic next spring we may expect appeareance of mucilages.
Thank you for the attention

To be in 2011...