Water Chemistry: A Fundamental Knowledge Base for Aquatic Ecosystem Management

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Water availability, water quality, water management and water governance are today at the center of discussion on water security and sustainability. The chemical composition of pristine inland waters is depending upon the hydrogeochemistry of the watersheds, geological background, soil type and the aquatic biota (this due to metabolism of aquatic organisms).

Water is the universal solvent. Dissolved substances in water are ions and anions, gases, nutrients for phytoplankton, macrophyte growth and photosynthetic bacteria. Nutrient such as phosphorus and nitrogen with different chemical species dissolved in water are thus fundamental for the biological productivity of the inland waters. Trace ions such as Cu^{+2} , Zn^{+2} , Mo^{+6} , organic refractory substances, such as humic acids and labile organic substances are also present in almost all inland waters: lakes, rivers, reservoirs, wetlands. High level of dissolved organic substances with complex molecules decreases oxygen concentration in all layers of water affecting the aquatic biota and the underwater radiation climate.

Geographic variability of principal dissolved substances and elements in natural pristine waters occurs due to the continental / regional differentiation in hydrogeochemistry. Processes of interest in an environmental context are:

- Leaching of ions and organic compounds in soil
- Evaporation of organic chemicals from soil and surface water
- Sedimentation of heavy metals and organic chemicals in aquatic ecosystems
- Hydrolysis of organic chemicals
- Dry-humid deposition from the atmosphere
- Chemical oxidation
- Photochemical processes

Biotic processes such as respiration, excretion and decomposition of organisms further complicate this picture. All the processes above described are first order reactions at least in some situations [1].

Human activity has resulted in extensive contamination of pristine waters all over Planet Earth. Even when some contaminants are natural components of soils, they can be mobilized and redistributed in potentially toxic forms throughout many industrial activities, or other man made actions. Several contaminants wash into the aquatic environment, dissolve in water or may settle in the sediments.

Good water quality, which is the basic chemical composition of water, is essential for water security. The history of degradation of water quality shows a continuous deterioration, with increasing complexity, mainly in the 20th century with cumulative impacts, increasing vulnerability of human populations and economic impacts. There is an increase in complexity of water analysis due to this degradation process [2]. Endocrine disruptors, pesticides, herbicides, cosmetics, antibiotics, and toxins dissolved in water turn the water chemistry a very important knowledge data base for water resources management.

Several million of different compounds and 100.000 chemicals have environmental interest because they may threaten the environment. The number of possible reactions among these chemicals is enormous. The solubility products of hydroxides, oxides, and carbonates have particular interest in aquatic chemistry because these anions are present in high concentrations in natural aquatic ecosystems [3].

Chemical analysis of waters from inland ecosystems is therefore fundamental for their management. This management is an interdisciplinary and complex operation. Chemical analysis of effluents from point sources, identification of non point sources of contamination, complexes formation, interaction sediment-water, are some of the problems to be solved and they are challenges for an adequate management perspective.

Acidification, eutrophication, very high concentration of toxic substances, are some of the problems that have to be solved by the development of advanced technologies and strategies in order to optimize multiple uses of surface waters. Contamination of underground waters is another threat to water quality.

Integrated environmental approach means that all biogeophysical, chemical, social and economic processes have to be considered for the overall systemic view necessary to promote water governance and water resources management.

In order to follow up water quality problems it is necessary to keep track of all material flows (in the air, water and soils) and their cycles in organic and inorganic compartments. Methodological and technical advances are relevant for the consolidation of chemical information on aquatic ecosystems.

Chemical analysis of fresh waters can help with the anticipation of impacts and or in the prediction capacity of future impacts [4].

Solving the analytical complexity and developing an advanced process of predictions is one important task for the future of aquatic chemistry, with a relevant contribution for the integrated management of inland aquatic ecosystems.

References

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