ASSESSMENT METHODS THAT CAN BE APPLIED FOR THE DETERMINATION OF THE AQUATIC POLLUTION STATE OF AREAS AFFECTED BY MINING ACTIVITIES

Contents

Introduction

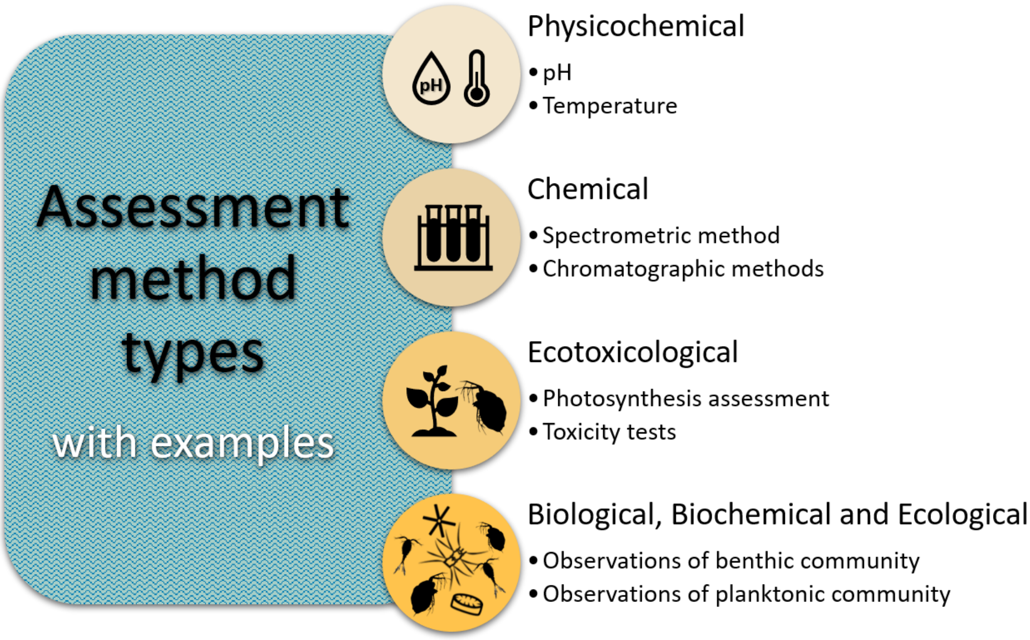
As water is of vital importance for life, the **pollution of water generated by mining activities** represents a **threat**. Thus, the protection of water bodies from pollution is essential. The first step in the protection of water from pollution is represented by the assessment of the current state of pollution generated by mining activities (Banerjee and Singh 1993).

Methods to assess the pollution state of water are necessary in order to evaluate the damages against the environment that mining activities produce, in order to take the adequate protection measures. These methods must be based on preliminary studies about waste properties, heavy metals content and their relation to the environment (Zhou 2015).

Assessment methods

The aquatic pollution state of areas affected by mining activities, including both surface water and groundwater pollution, can be assessed by different method types, such as:

- physicochemical
- chemical
- ecotoxicological
- biological, biochemical and ecological



Physicochemical analyses

Some physicochemical methods, that can be applied to analyze the pollution state of water samples, are:

- pH (Bouzekri, El Hachimi et al. 2020)
- alkalinity (Sima, Zobrist et al. 2008)
- acidity (Sima, Zobrist et al. 2008)
- conductivity (Bouzekri, El Hachimi et al. 2020)
- temperature (Bouzekri, El Hachimi et al. 2020)
- hardness (Liu, Coveney et al. 2003)
- dissolved oxygen (DO) (Ashraf, Maah et al. 2012)
- total dissolved solids (TDS) (Ashraf, Maah et al. 2012)
- turbidity (Ashraf, Maah et al. 2012)

Chemical assessment methods

The chemical methods for water sample analysis from areas affected by mining activities involve the determination of the concentration of different mining pollutants. These methods rely on the use of specific equipment and techniques such as:

Equipment / Method	Pollutants analyzed	References
Ion-exchange chromatography	K^+, Mg^{2+}, Ca^{2+}, Na^+, HCO^{3-}, F^-, SO_4^{2-}, NO^{3-}, Cl^-	(Sima, Zobrist et al. 2008, Bouzekri, El Hachimi et al. 2020)
Atomic Emission Spectrometry with Inductively Coupled Plasma (ICP-AES)	Pb, As, Cd, Cu, Zn	(Bouzekri, El Hachimi et al. 2020)
Inductively coupled plasma-optical emission spectrometry (ICP-OES)	heavy metal, arsenic, major base cations	(Sima, Zobrist et al. 2008)
Inductively coupled plasma-optical mass spectrometry (ICP-MS)	heavy metals	(Romero-Freire, Minguez et al. 2018)
Diffuse gradient in thin film (DGT) technique	pure dissolved heavy metals	(Sima, Zobrist et al. 2008)
Total organic carbon (TOC) analyzer	dissolved organic carbon (DOC)	(Liu, Coveney et al. 2003)

Ecotoxicological assessment methods

Some of the ecotoxicological assessment methods of water samples from areas affected by mining activities that can be applied are described in the following table:

Test / Method	Organisms used	Recommended species	References
Microbial toxicity test	luminescent marine bacteria	*Aliivibrio fischeri* *Photobacterium phosphoreum*	(Romero-Freire, Minguez et al. 2018) (Liu, Coveney et al. 2003)
Photosynthetic efficiency test based on the production of chlorophyll fluorescence	green algae	*Chlorella vulgaris*	(Romero-Freire, Minguez et al. 2018)
Mudsnail toxicity test	mudsnalils	*Potamopyrgus antipodarum*	(Sullivan, Wright et al. 2014)
Ostracod chronic toxicity test	ostracods	*Heterocypris incongruens*	(Romero-Freire, Minguez et al. 2018)
Daphnid toxicity test	daphnids	*Daphnia magna*	(Liu, Coveney et al. 2003)
Germination and root elongation toxicity test	monocotyledonous or dicotyledonous plants	*Lactuca sativa*	(Romero-Freire, Minguez et al. 2018)

The assessment of ecotoxicology of water samples from areas polluted by mining activities can also be done through the testing of the effects of determined pollutants (such as heavy metals) on selected test organisms. The effects can be determined through methods such as:

- toxicity, mortality, growth or uptake assays on different organisms (Nor 1987)
- bioinformatic methods for the determination of potential toxicity using different model organisms (Nor 1987)

Biological, biochemical and ecological assessment methods

Some biological, biochemical and ecological assessment methods are:

- water quality assessment that involves the calculation of water quality indices that can be:
  - specific to mining pollution such as the heavy metal pollution index (HPI) (Tiwari, De Maio et al. 2015)
  - non-specific which include parameters such as dissolved oxygen (DO), pH, turbidity, specific conductance, alkalinity, salinity etc. (Stubblefield, Chandra et al. 2005, Tyagi, Sharma et al. 2013)

- aquatic ecosystems assessment that involves:
  - macroinvertebrate collection from water polluted by mining activities
  - macroinvertebrate identification
  - determination of biotic indexes base on macroinvertebrate type ratios (Liu, Coveney et al. 2003, Sullivan, Wright et al. 2014)
  - assessment of the effect of mining generated pollution to phytoplankton communities (Oliveira 1985)
  - assessment of the effect of mining generated pollution to zooplankton communities (Goździejewska, Skrzypczak et al. 2018)

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