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

Contents

1 ASSESSMENT METHODS 1
1.1 PHYSICOCHEMICAL ANALYSES 1
1.2 CHEMICAL ASSESSMENT METHODS 1
1.3 ECOTOXICOLOGICAL ASSESSMENT METHODS 2
1.4 BIOLOGICAL, BIOCHEMICAL AND ECOLOGICAL ASSESSMENT METHODS 2

1 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

1.1 Physicochemical analyses

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

- pH [1]
- alkalinity [2]
- acidity [2]
- conductivity [1]
- temperature [1]
- hardness [3]
- dissolved oxygen (DO) [4]
- total dissolved solids (TDS) [4]
- turbidity [4]

1.2 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^-	[1, 2]
Atomic Emission Spectrometry with Inductively Coupled Plasma (ICP-AES)	Pb, As, Cd, Cu, Zn	[1]

Inductively coupled plasma-optical emission spectrometry (ICP-OES)	heavy metal, arsenic, major base cations	[2]
Inductively coupled plasma-optical mass spectrometry (ICP-MS)	heavy metals	[5]
Diffuse gradient in thin film (DGT) technique	pure dissolved heavy metals	[2]
Total organic carbon (TOC) analyzer	dissolved organic carbon (DOC)	[3]

1.3 Ecotoxicological assessment methods

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*	[5] [3]
Photosynthetic efficiency test based on the production of chlorophyll fluorescence	green algae	*Chlorella vulgaris*	[5]
Mudsnail toxicity test	mudsnalils	*Potamopyrgus antipodarum*	[6]
Ostracod chronic toxicity test	ostracods	*Heterocypris incongruens*	[5]
Daphnid toxicity test	daphnids	*Daphnia magna*	[3]
Germination and root elongation toxicity test	monocotyledonous or dicotyledonous plants	*Lactuca sativa*	[5]

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 [7]
- bioinformatic methods for the determination of potential toxicity using different model organisms [7]

1.4 Biological, biochemical and ecological assessment methods

The 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) [8]
  - non-specific which include parameters such as dissolved oxygen (DO), pH, turbidity, specific conductance, alkalinity, salinity etc. [9, 10]
- aquatic ecosystems assessment that involves:
  - macroinvertebrate collection from water polluted by mining activities
  - macroinvertebrate identification
  - determination of biotic indexes base on macroinvertebrate type ratios [3, 6]

References

1. Bouzekri, S., et al., *Metal pollution assessment of surface water from the abandoned Pb mine Zaida, high Moulouya-Morocco.* Geosystem Engineering, 2020: p. 1-8.
2. Sima, M., et al., *ENVIRONMENTAL POLLUTION BY MINING ACTIVITIES--A CASE STUDY IN THE CRIŞ ALB VALLEY, WESTERN CARPATHIANS, ROMANIA.* GeoEcoMarina, 2008. **14**(1).
3. Liu, W.X., R.M. Coveney, and J.L. Chen, *Environmental quality assessment on a river system polluted by mining activities.* Applied Geochemistry, 2003. **18**(5): p. 749-764.
4. Ashraf, M.A., M.J. Maah, and I. Yusoff, *Morphology, Geology and Water Quality Assessment of Former Tin Mining Catchment.* The Scientific World Journal, 2012. **2012**: p. 369206.

5. Romero-Freire, A., et al., *Assessment of baseline ecotoxicity of sediments from a prospective mining area enriched in light rare earth elements.* Science of The Total Environment, 2018. **612**: p. 831-839.
6. Sullivan, R., et al. *The assessment of impacts from mining wastes on water quality and aquatic ecosystems using freshwater macroinvertebrate communities and novel bio-assay tests*. in *Proceedings of the 7th Australian Stream Management Conference: Catchment to Coast, Townsville, Queensland, 27-30 July 2014*. 2014.
7. Nor, Y.M., *Ecotoxicity of copper to aquatic biota: A review.* Environmental Research, 1987. **43**(1): p. 274-282.
8. Tiwari, A.K., et al., *Evaluation of Surface Water Quality by Using GIS and a Heavy Metal Pollution Index (HPI) Model in a Coal Mining Area, India.* Bulletin of Environmental Contamination and Toxicology, 2015. **95**(3): p. 304-310.
9. Tyagi, S., et al., *Water quality assessment in terms of water quality index.* american Journal of water resources, 2013. **1**(3): p. 34-38.
10. Stubblefield, A., et al., *Impacts of gold mining and land use alterations on the water quality of central Mongolian rivers.* Integrated Environmental Assessment and Management, 2005. **1**(4): p. 365-373.