Climate Change Risks for Safety of the Mining Tailing Dams and Proposition for Some Solutions

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Keywords: mining tailings, climate change, remediation, nanotechnology
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Geotechnical construction could suffer greatly in the future due to the accelerating climate change. Between these structures, the soil covers used in mining tailing dams are some of the most vulnerable constructions. Tailing dams failures have been increasingly common during 20 century especially during 1950's to 1970's often causing human life loss (Azam & Li, n.d.).

These failures are dangerous both from the point of view of direct threat to the human populations often living near them and even below the level of the dams, but also from the environmental point of view, since quite often tailings contain toxic metals or have aggressive pH value (Ahmad, 2018; Hoelzl, n.d.). Some contrasted examples will be presented in this paper on the study conducted in Bosnia and Herzegovina, such as iron mining tailing dam which is not toxic per se, and also an example of the red mud tailing which is highly caustic and carrying certain amounts of the toxic metal residues (Figure 1).

Figure 1. Red mud tailings dam from bauxite processing (left, Zvornik, Bosnia and Herzegovina) and iron mine tailing dam from magnetic separation (right, Prijedor, Bosnia and Herzegovina)

Present study is concerning in this country since it is one with the densest mining activities in Europe at present, with number of new international investment contracts in mining on the way or already signed. Therefore, to preserve the natural landscape and heritage with great potential for tourism, safety of the dams has to be strongly considered along with the green mining technologies for minimization of the waste accumulation.

Climate change in Bosnia and Herzegovina has been very pronounced in the past few decades. They are manifested through an increase in air temperature, changes in the pluvimetric regime and an increase in the intensity and frequency of climate extremes.

In the historical period (1961-2016), based on official data obtained from the Hydrometeorological Institute of Republika Srpska (RMZ RS) for Banja Luka and the Federal Hydrometeorological Institute of the Federation of BiH (FHMZ) for Tuzla, an increase in the number of days with intense rainfall of 20mm is evident (Figure 2). The meteorological stations Banja Luka and Tuzla were chosen due to the proximity of the investigated locations, and the stations where monitoring is performed are of the first order. Also these two regions large number of tailings, between them also those represented at Figure 1, which are the largest ones. The appearance of such intense precipitation can cause a very fast inflow of large amounts of water in a small area. Rapid water contact can pose a threat to reservoirs in Prijedor and Zvornik.

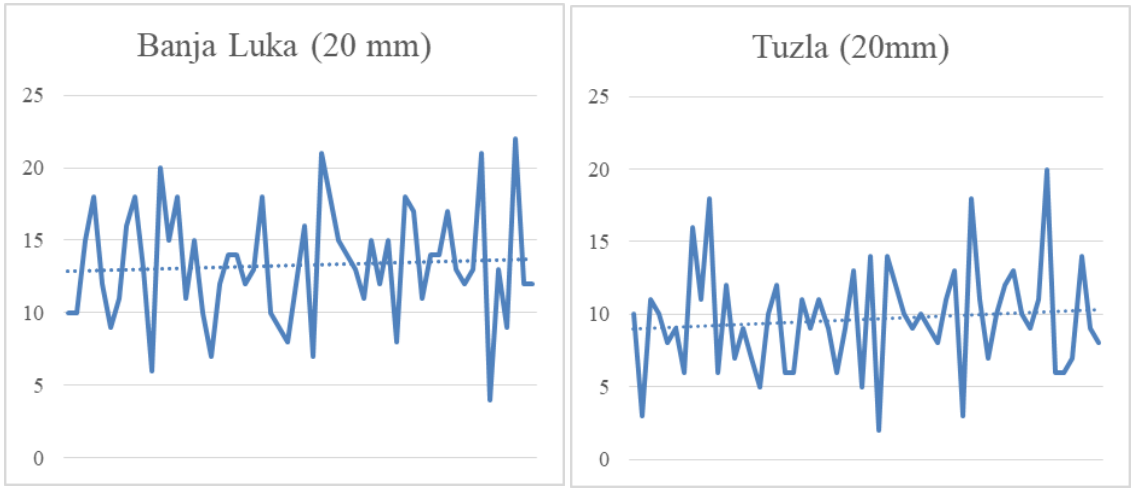

Figure 2. Change in the trend of intense precipitation (20mm) in Banja Luka (left) and Tuzla (right)

In addition to these precipitations, the presentation will show analysis of the changes in five-day precipitation with 60 mm accumulations and their expected change according to the climate scenario RCP8.5 by the end of the XXI century, for three time horizons (2011-2040, 2041-2071 and 2071-2100).

Climate projections indicate that there will be an increase in the number of days with intense rainfall (R5D60) in the interval from 1.5 to 3 at the investigated locations (Figure 3). Such changes can pose a threat to large inflows of water, floods and spills of contents from reservoirs into the surrounding area.

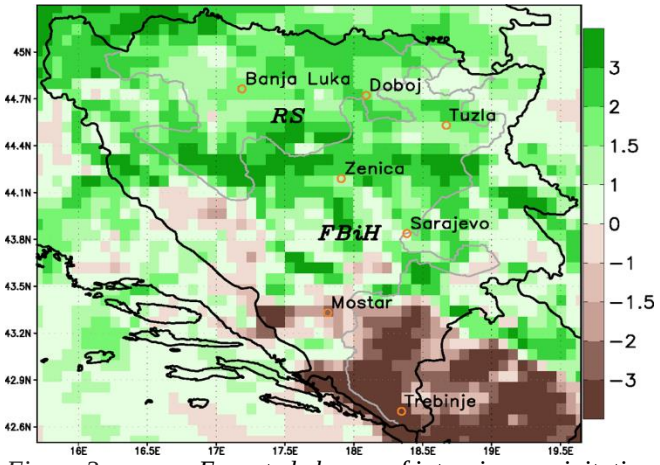

Figure 3. Expected change of intensive precipitation (climate index R5D60) in Bosnia and Herzegovina for the period 2011-2040. in relation to the base period (1971-2000)

Finally, present study would like to emphasize the potential of the reduction or even complete removal of the accumulations of the mining tailings by their application in nanotechnology, which has also been recently patented(Gotovac Atlagić et al., 2021). In particular, the metals contained in the tailings are present in a very fine micro powdered form. Their extraction necessary involves chemical dissolutions or extractions after which the metallurgical use is not economical anymore. However, using these concentrated metal solutions and careful application of the cationic separation followed by established procedures for nano-synthesis, valorization of such remediated metal ions can produce highly valuable nanomaterials (Atlagić et al., 2021). Examples of successful synthesis of hematite and magnetite nano and micro particles produced exclusively from the iron and red mud tailings sludge, will be shown.

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