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Review

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Abstract: A detailed analysis of the accident that occurred at the flotation tailings storage facility (TSF) at the inactive mine "Stolice" in 2014 is provided in this paper. All factors that caused the accident have been analyzed, with a review of the consequences of the accident, their accident class according to the Global Industry Standard on Tailings (GISTM), and the implemented measures to rehabilitate the TSF and the surrounding area after the accident. It has been concluded that the TSF had not been properly maintained even before the accident occurred and that the unfavorable weather conditions in Serbia in the May of that year contributed to the filtration disturbance and multiple tailings spillages from the TSF. It has been stated that the consequences according to the GISTM span from "low" to "significant", with the group of environmental consequences having the highest rank (3). Although the accident occurred without recorded human casualties, with the damage being of a local nature, it is considered one of the most significant accidents at a TSF in Serbia in the last 20 years. The reconstructed TSF is considered stable now, with a low-to-medium risk of failure.

Keywords: flotation tailings storage facility; mine "Stolice"; accident; consequences; GITSM

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1. Introduction

All human activity is risky by nature, and all man has ever made is prone to destruction [1]. Flotation tailings storage facilities (TSFs), as objects for the permanent storage of flotation tailings, due to their large dimensions and the nature of the tailings deposited there in the form of hydromixtures, are very often places where smaller or bigger accidents occur [2,3]. A few serious accidents at flotation tailings storage facilities have been recorded in Serbia in the past, which occurred without human casualties but were followed by material and ecological damage, usually of a local nature [4]. Some of the most relevant accidents are the outpouring of 7,000,000 t of tailings through the cave opening in the side of the TSF "Valja Fundata" in Majdanpek in 1974, and the pollution of the Veliki Pek River [5], as well as the collapse of the embankment at the TSF "Šaški potok" in Majdanpek and the outflow of around 100,000 t of tailings in the surrounding watercourses in 1996 [6].

In 2014, an accident occurred at the flotation TSF of the inactive mine "Stolice" in West Serbia, whose ecological consequences are still visible in the area. When this accident occurred, it did not receive the public's attention as much as it perhaps deserved due to the fact that it was only one of the consequential events caused by the weather disasters that persisted for days in Serbia in May of 2014 and contributed to the general paralysis of life in that period. Although the dimensions of the accident were significant, there was no immediate reaction as other parts of the country required more urgent assistance at that moment in time. Luckily, this accident occurred without human casualties, but the other consequences were significant [7].

The base goal of this paper is to provide an overview of all aspects of the flotation TSF of the "Stolice" mine and the accident that occurred, with a review of the causing factors, the consequences of the accident, and the post-accident measures taken to understand the damage visited upon the environment more adequately. A decade later, a retroactive overview of the nature of this accident is very important so that lessons can be learned and similar events prevented in the future. The analysis of the measures taken to reconstruct the TSF will provide input data for the assessment of other potential accidents at the same TSF.

2. History and Location of the "Stolice" Mine and TSF

The antimony mine "Stolice" and TSF are located in Western Serbia in the Krupanj municipality (Figure 1). At one time, it was the largest antimony mine in Serbia. The first investigative works in the mine started at the end of the 19th century so that the mine could begin serious work and supply the smelter with more than 90% of the ore in 1916 under the management of the then-owners from Austria. The mined ore was prepared in the mine and then transported to the smelter where a concentrate with 40% Sb was obtained. After World War I, the mine temporarily stopped working, to be renewed in 1936 under the management of the new owner of "Podrinje Consolidated Mines Ltd.". The mine was operational until World War II, when the former country the Kingdom of Yugoslavia surrendered, and the mine was taken over by Germans. Due to the rebellion of the insurgents, the mine temporarily stopped working in 1942. After the war ended, the mine "Stolice" became a part of the public company The "Zajača" Mining Smelter Basin. In 1960, a flotation concentration facility began operating within the mine, with an ore processing capacity of 50,000 t/year. This capacity was increased during the facility reconstruction in 1981 to 80,000 t/year. For the purpose of storing the tailings created during mineral processing, the flotation TSF was built [8,9].

Figure 1. The location of the of the mine "Stolice" and TSF.

The mine was operational until 1990 when the last available ore reserves were mined. Issues involving the increased amount of arsenic in the concentrate, which regularly accompanies the antimony ore, as well as the insufficient economic justification for the exploitation, were stated as the reasons for cessation of work. The mine, although inactive, was privatized along with other mines in the Krupanj region in 2006, when it became the property of the Concern "Farmakom MB" from Šabac [10].

The flotation TSF of the mine "Stolice" represents the valley type of hydraulic TSF, consisting of two fields: eastern and western. It was built up using the introductory method of hydrocyclone sand, which involves the construction of an initial embankment with material from the borrow pit, on which peripheral embankments from the tailings are then added. With this method, the superstructure is built in levels, the height of which ranges from 3 to 5 m, starting towards the center of the TSF. Every subsequent level rests on the formerly deposited silty tailings, which may negatively impact the stability of the TSF. Due to the segregation and deposition of the material in the form of hydromixtures, a sedimentary lake is formed [5]. The principle of the formation of the flotation TSF of the "Stolice" mine in stages is shown in Figure 2.

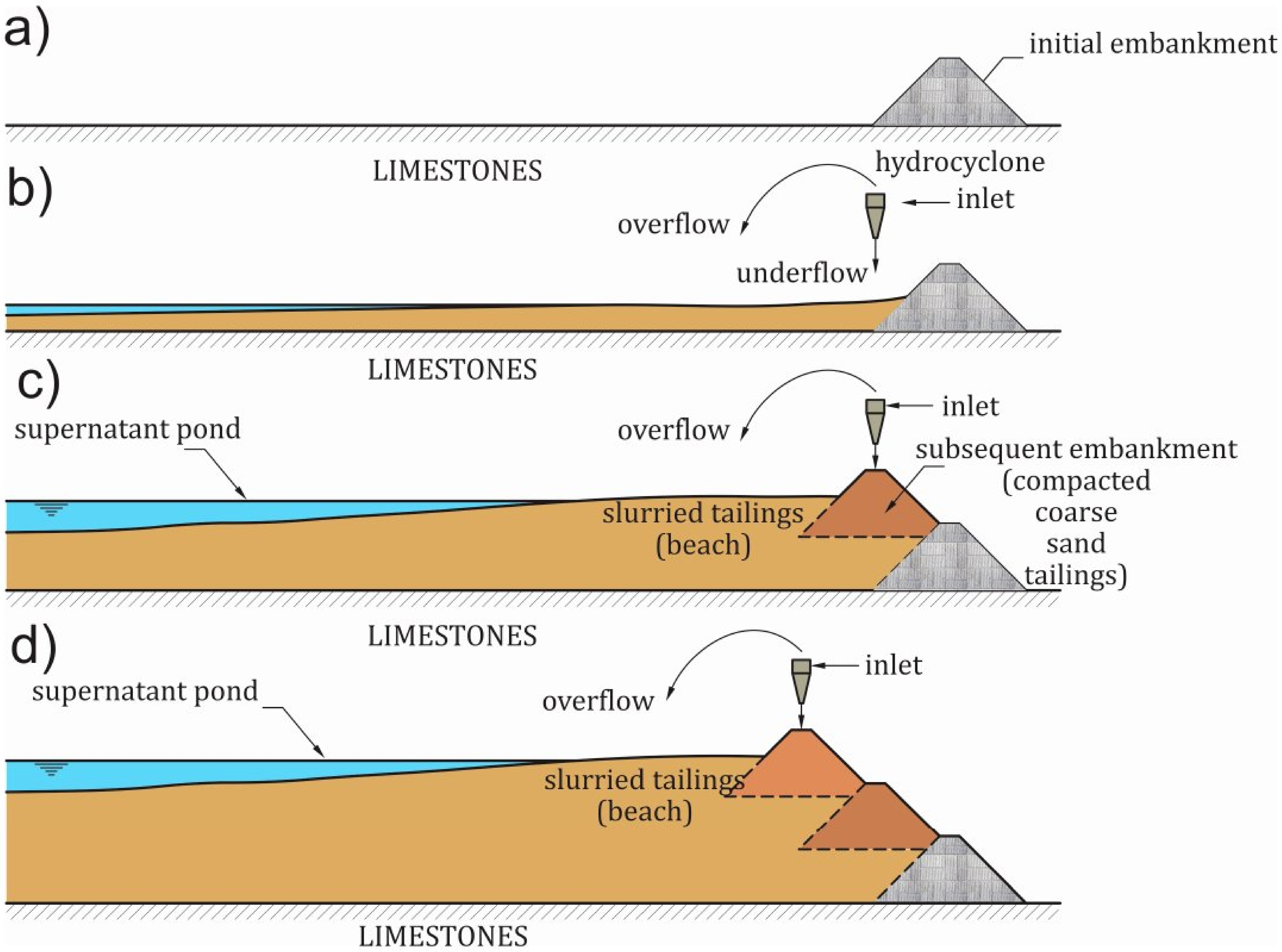

Figure 2. The principle of forming the TSF during the operation of the mine "Stolice": (**a**) forming of the initial embankment; (**b**) classification of tailings in the hydrocyclone, during which a subsequent embankment is built out of sand, and the overflow is poured into the storage space; (**c**) segregation of the deposited tailings and formation of the supernatant pond; (**d**) the expansion of the TSF by building levels towards the center of the landfill.

The total surface of the TSF is 32,500 m^2, with the western field being 13,800 m^2 and the eastern one being 10,500 m^2 [11]. During its operational life, a total of 1,200,000 t of tailings was deposited [12], which amounts to around 450,000 m^3 of tailings. In the deposited tailings, Pb, Zn, Cu, Cd, Co, Ni, Sb, Sn, As, Hg, and Fe are dominant [13].

The TSF is located in Kostajnik (44.408785°, 19.321561°, 390 m.a.s.l) in the basin of the Kostajnička River, about 150 km southwest of Belgrade, to the right of the state road, class IIa, no. 139 (Krupanj-Korenita-Krst). It is contoured in such a way that it covers two ravines of the so-called Bezimeni stream, which flows into the Kostajnička River. The Bezimeni Stream was introduced into a 300 m long pipe culvert, while the other part of the stream was carried through the drainage system to the Kostajnička River, which, together with the Duboki Stream, forms the Korenita River, the left tributary of the Jadar River. In a broader sense, the location of the TSF belongs to the catchment area of the Drina [10].

The surrounding area around the TSF is sparsely populated, including the hinterland of the Podrinje mountains: Gučevo, Boranja, Sokolska Mountain, and Jagodnja. It is overgrown with pine and Turkey oak forest and has a very steep terrain. In the valleys of the Kostajnička River and the Korenita River, there are small arable areas, buildings, and homesteads of agricultural households. Concrete and stone walls, which cover parts of the beds of these rivers, are in the parts of the stream that are in the immediate vicinity of the road and households. The climate in this region is moderately continental to continental, with cold winters, warm summers, and rainy autumns and springs [14].

3. Accident Description

The flotation TSF of the "Stolice" mine has not been active since 1990. According to the image of the TSF from 2012 (Figure 3a), it is clear that the embankment on the west field of the TSF was already damaged. Regardless of this fact, no accidents had been recorded at this TSF before. During May of 2014, the so-called "Tamara" cyclone caused heavy rainfall and caused what are considered to be the largest floods ever recorded in certain parts of Central and West Serbia [15]. The region of the TSF of the mine "Stolice" had 200–250 mm of rainfall in only 3 days, surpassing the so-called 100-year flood [16].

Figure 3. The flotation TSF of the mine "Stolice": (**a**) image from 2012, before the accident; (**b**) image from 2016, after the accident and before rehabilitation; (**c**) image from 2024, after rehabilitation [17].

The accident ran through four phases from May to July 2014, each contributing to the overall damage and environmental impact of the accident [5,10,18].

3.1. First Phase: Breach of the Eastern Field Embankment

On 13 May 2014, due to the inflow of a large amount of precipitation and the saturation of tailings with water, there was a filtration disturbance in the eastern field embankment, and as the drainage worked poorly, it caused a break in the embankment and there was an overflow of the deposited tailings from the eastern field (Figure 4). On that occasion, a flood wave was formed, and the spilled tailings reached the Kostajnička River, where they were further transported to the Korenita River. Considering that there was intense rainfall for days (from 13 to 16 May), the spilling of eastern field tailings was recorded for days. Until that moment, the western field was stable, without visible water on the surface.

Figure 4. The damaged embankment of the eastern field. Reproduced with permission from the Water Institute "Jaroslav Černi" [10].

3.2. Second Phase: The Occurrence of a Landslide Above the Western Field

Just two days later, on 15 May 2014, continuous rainfall triggered a natural landslide above the western field. The landslide was particularly concerning because it added a large amount of debris into the western field, which was already at risk due to the heavy precipitation. The additional weight from the landslide further stressed the embankment, weakening its integrity. On that occasion, the pipe culvert regulating the Bezimeni Stream on the western flank of the TSF was damaged (Figure 5).

Figure 5. The damaged pipe culvert on the western field. Reproduced with permission from the Water Institute "Jaroslav Černi" [10].

3.3. Third Phase: Breach of the Western Field Embankment

On 23 May 2014, the Bezimeni stream began to fill the western field with water, which finally caused the western field embankment to breach [5]. An even larger volume of tailings into the surrounding environment was released than in previous phases. The release of tailings lasted for days after those temporary measures for the reconstruction of the TSF were introduced. The improvised wooden embankment was installed (Figure 6).

Figure 6. The improvised wooden embankment of the eastern field. Reproduced with permission from the Water Institute "Jaroslav Černi" [10].

3.4. Fourth Phase: Another Breach of the Eastern Field Embankment

On 17 July of the same year, the tailings spilled again when the already-damaged eastern field embankment, which was temporarily blocked off by the wooden embankment at that moment, was breached and additional tailings spilled into the Kostajnička River (Figure 7) [18]. The repeated failure highlighted the need for more robust remediation efforts and long-term solutions to prevent future accidents of this nature.

Figure 7. The temporarily blocked eastern tailings field was breached again on 17 July 2014. Reproduced with permission from N1 Television [19].

After the accident, tailings outflow continued during the following rainy days. On average, 20–30 m^3 of tailings were poured into the Kostajnička River. The spill was definitively stopped by the implementation of the first remediation measures in 2014 [11].

4. Accident Consequences

During the accident, a total of between 70,000 and 100,000 m^3 of the deposited tailings spilled from the TSF, with most of the tailings spilling from the eastern field [20]. The beds of the Kostajnička River and the Korenita River were devastated, especially the unregulated parts of the riverbeds. The spilled tailings were deposited on the banks of the Kostajnička River, spanning 5 km, and the Korenita River, spanning 20 km, up to the confluence with the Jadar River [11]. Downstream from the TSF, deposits of spilled tailings were created, which were 5–10 cm thick and 50–75 m wide (Figure 8a,b) [21]. It has been estimated that the total contaminated surface of the arable and non-arable land was around 400 ha. Road No. 149 was completely closed off, and several residential buildings were completely demolished [10]. There were no human casualties [5].

Figure 8. Tailings deposits in the bed of the Kostajnička River (**a**) and on the surrounding terrain (**b**). Reproduced with permission from the Water Institute "Jaroslav Černi" [10].

According to the Report on the State of the Environment in the Republic of Serbia in 2014 [22], the results of the analysis of agricultural land samples near the TSF showed elevated concentrations of As (4118.9–4560 mg/kg), Cd (9.5–13.4 mg/kg), Pb (385–448 mg/kg), Zn (1221.4–1630 mg/kg), and Hg (6.3–10 mg/kg) according to the Regulation on the programme of systematic monitoring of soil quality via indicators for assessment of soil degradation risk and the methodology for the creation of remediation programmes ("Official Gazette of the RS" No. 88/10 of 23 November 2010) [23].

According to [24], in 95% of the soil samples that were taken in the flooded area in 2017, it was found that the remediation value, according to the regulation [23], which for Sb is 15 mg/kg, was exceeded 18 times, while the remediation value for As (55 mg/kg) was exceeded 8.5 times 3 years after the accident; while [25], in their research in 2018, proved that the Sb, Hg, Pb, Cd, and Zn contents, as well as the pollution index, decrease with distance from the TSF.

Based on information about the content, distribution, and appearance of microelements, especially potentially toxic (As, Be, Cd, Co, Cr, Cu, Hg, Mn, Ni, Pb, Sb, Se) and radioactive ones, different impacts on the environment and human health can be predicted. Studies have shown that certain amounts of Cd, As, Cr, and Ni cause cancer in humans, while Be, Cd, Co, Cr, Mn, Ni, and Pb have a carcinogenic effect on animals [26]. In previous research, it has been observed that the ions of certain microelements isomorphically replace the "host metal ions" in soil minerals. For example, in the crystal lattice of clay minerals, vanadium easily replaces aluminum, and in goethite (a ubiquitous hydrated iron oxide), the Fe^{3+} ion can be isomorphically replaced by Cr^{3+}, Ni^{2+}, Cu^{2+}, Zn^{2+}, Cd^{2+}, or Pb^{2+} ions. The calcium ion in calcite is relatively easily replaced by Zn^{2+}, Sr^{2+}, Ba^{2+}, and Pb^{2+}. Rubidium and cesium, like potassium, have a high affinity to be sorbed even irreversibly in the interlayer spaces of clay minerals, montmorillonite, and illite. Ions of microelements are sorbed into the primary and secondary layers of colloids and participate in ion exchange reactions. As in the case of macroelements, the affinity for sorption increases with the increasing charge and increasing radius due to a lower degree of hydration. Co-precipitation with carbonates, which is the most widespread calcite, is a very significant mechanism in the immobilization of heavy metal ions, especially when it comes to Zn, Cd, and Sr [27].

In comparing the concentration values of individual microelements in soil samples from the flooded area around the TSF along the Kostajnička river (44°23.830′ and 44°38.100′ N and 19°15.350′ and 19°23.750′ E) given in the last examination of this region, which was conducted by [25] in 2018 with the permitted values shown in Table 1, it is concluded that the concentrations of Zn, As, and Sb are significantly elevated, while the measured values of Cd and Pb concentrations slightly deviate from the permitted values. The recorded Hg, Mn, Cr, Ni, and Cu concentrations correspond to the permitted ranges. At the same time, it is noted that the upper values of the measured concentrations are significantly lower than the values predicted as optimal for these microelements. The content of certain microelements in the soil from a geochemical and mineralogical aspect will depend primarily on the different chemical and physical properties of the environment, on migration, on the chemical stability of the microelements, on the mineral composition of the rocks, and on the influence of external factors, which can lead to significant changes in their concentrations in the soil. Potentially toxic elements, such as As, Cd, Zn, Hg, Mn, Ni, Cr, Cu, etc., are not biodegradable; therefore, they can be transported a long distance from the TSF itself. If their amounts are not significantly increased, as is the case with Hg, Mn, Cr, Nim, and Cu, their concentration may decrease significantly due to longer migrations.

Table 1. Found concentration ranges during soil testing in the vicinity of the flotation TSF of the "Stolice" Mine in 2014 and allowed concentration ranges of microelements.

Microelements	Concentrations from 2018 (mg/kg), Data from [25]	Allowed Concentration (mg/kg) [27]
Zn	50.33–1999.87	70–400
As	0–4936.16	15–50
Cd	0.1–11.26	3–8
Hg	0–1.46766	0.3–5
Pb	15.26–468.29	100–400
Sb	0–1467.77	5–10
Mn	145.98–1265.73	1500–3000
Cr	7.92–46.58	75–100
Ni	11.98–60.26	100
Cu	11.4–36.44	60–125

There were no deposits of spilled tailings along the Jadar riverbed. The total amount of settled tailings and contaminated soil that needed to be removed was estimated at almost 250,000 m^3 [11]. According to water quality analyses from 2013, the Jadar River was between class I and II, and after 2015, repeated analyses showed that its class varied between III and V according to the Regulation on Limit Values of Pollutants in Surface and Underground Waters and Sediment and Deadlines for Reaching them ("The Official Gazette of RS no. 50/2012") [28]. Regardless of these data, it was determined that there is no risk of pollution of the Drina River basin that would threaten the water supply of that district [7]. Figure 3b shows the condition of the TSF from 2016, after the accident, and before the final rehabilitation.

5. Measures Taken After the Accident

Remediation measures of the TSF and its surroundings were carried out in three phases [10,11]:

- The cleaning of houses and yards was started in the first phase, which was carried out by the locals themselves. Through the United Nations Office for Project Services and the then Ministry of Construction, Transport, and Infrastructure of the Republic of Serbia, the Korenita–Krupanj road (road no. 139) was rebuilt and reopened in July 2014. At the same time, work began on the cleaning of the Kostajnička River and the Korenita River, which was mostly carried out by local residents whose households were located on the banks of the rivers. In the upper part of the course of the Kostajnička River, several flood barriers were constructed on the Kostajnička River and its tributaries. Upstream from the landfill, a catch basin was built with the intention of receiving the waters of the Bezimeni Stream and introducing them into the drainage system in order to reduce erosion and thus reduce the washing of tailings into the Kostajnička River.
- In the second and third phases, organized measures to rehabilitate the TSF and flooded terrain initiated by the Government of the Republic of Serbia were carried out. Within a zone of 100 m from the TSF, spilled tailings were removed where deposits were thicker than 5 cm, biological remediation measures were applied through controlled

production and the use of biomass on flooded surfaces, and monitoring of the cleaning effects was planned for a period of at least 3 years.

The reconstruction of the TSF included the following [11]:

- Reprofiling of the TSF, which included the excavation, moving, and backfilling of the existing tailings which resulted from the cleaning of the downstream flooded terrain, amounting to about 110,000 m^3;
- Formation of settling tanks downstream of the TSF for leachate with a system for recirculation and evaporation in order to prevent leakage of leachate from the TSF into downstream watercourses;
- The formation of a stone dam in front of the TSF and before the settling tank, which has the function of additionally supporting the reconstructed embankments of the TSF;
- The creation of a space for the disposal of additional amounts of tailings that were caught during the cleaning of the flooded terrain;
- Reconstruction of the peripheral embankments.

The stability of the reconstructed TSF is ensured according to the criterion for large dams with respect to precipitation with probability of occurrence 0.1% (once in 1000 years). The costs of removing tailings from the riverbed of the Korenita and Kostajnička rivers, the reconstruction of the TSF itself, and the cleaning of the flooded surrounding terrain amounted to 1,072,101,000.00 dinars [11], i.e., according to the middle rate of the National Bank of Serbia fir euros and US dollars from September 2016 [29], when the rehabilitation was completed, about 8,695,060.00 euros, i.e., 9,755,241.00 dollars. Figure 3c shows the current state of the TSF after all rehabilitation measures have been taken.

6. Accident Consequences Classification

For the purpose of classifying the consequences that resulted from the accident at the flotation TSF of the "Stolice" mine, this paper used the recommendations of the Global Industry Standard on Tailings (GISTM), which classifies the consequences into one of 5 categories of severity (low, significant, high, very high, and extreme). When classifying, the consequences for people, the environment, people's health, infrastructure facilities, and the economy of the local community, as well as sociological and cultural damage, are taken into account. The consequences are considered individually, and one of the proposed categories is chosen, whereby the consequences for humanity are considered in two ways: the number of people exposed to risk; and the number of potential human losses. The number of human losses comes from the number of people exposed to risk. The consequences classification process is fully described in Table 1, Annex 2, of the Global Industry Standard on Tailings report [30].

Although this standard predicts the classification of consequences preventively in order that the output data could suggest measures for the proper management of the TSF so that accidents do not occur at all, the proposed classification is very applicable to real cases of accidents that have already occurred. For this reason, for the purposes of the accident at the flotation TSF of the "Stolice" mine, true, recorded data on the damage caused were taken, and realistic categories of consequences were obtained. For easier understanding of the class of consequences, ranks 1–5 have been added to the predetermined descriptive classes predicted by GISTM in this paper.

Table 2 shows the assessed classifications of consequences so the consequences for humanity are classified as "low" (rank 1), the consequences for the environment are in the class between "significant" and "high" (rank 2–3), sociological, cultural, and damage to health are in the class between "low" and "significant" (rank 1–2), while damage to infrastructure facilities and the economy is classified as "significant" (rank 2). The classifications of consequences assessed in this way indicate that the most critical classification is assigned to consequences for the environment, which certainly corresponds to the real situation.

Table 2. Category of accident consequences on the flotation TSF of the "Stolice" mine (the observed consequences are classified into the proposed categories according to the narrative contained in the GISTM) according to modified recommendations of the GISTM [30].

<table>
<tr><th colspan="7">Incremental Losses</th></tr>
<tr><th>Embankment Failure Consequence Classification</th><th>Rank</th><th>Potential Population at Risk</th><th>Potential Loss of Life</th><th>Environment</th><th>Health, Social and Cultural</th><th>Infrastructure and Economics</th></tr>
<tr><td>Low</td><td>1</td><td>It is unknown how many people were exposed to risk at the time of the accident.</td><td>0</td><td></td><td rowspan="2">As a result of the accident, significant effects were recorded on the living and working conditions of the locals, but there is little likelihood of an impact on human health. No damage to the cultural and historical heritage of the area was recorded.</td><td></td></tr>
<tr><td>Significant</td><td>2</td><td></td><td></td><td rowspan="2">The area affected by the accident is <20 km^2. Partial remediation was carried out within 1–5 years; however, in some parts, the consequences are still noticeable, so it can be concluded that more time is needed (>5 years). There is no disturbance of critical habitats of rare and endangered species. It is possible that there has been local pollution of water sources for feeding livestock, without health risks.</td><td>The estimated costs of rehabilitation and remediation are less than 10,000,000 dollars, and there are no costs for the operation of the mine because it was not active for 10 years before the accident.</td></tr>
<tr><td>High</td><td>3</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Very High</td><td>4</td><td></td><td></td><td>/</td><td></td><td>/</td></tr>
<tr><td>Extreme</td><td>5</td><td></td><td></td><td>/</td><td></td><td>/</td></tr>
</table>

7. The Potential of an Accident at the Reconstructed TSF

The stability analysis of the reconstructed TSF was conducted for a characteristic longitudinal section, marked as Section 1–1′ in Figure 9a. This section was chosen because in the case of the worst possible scenario, it would give the worst results due to the largest amount of deposited tailings along that section and steep angles of the surrounding terrain [11].

Stability analysis was conducted with the SLIDE v5.0 programme developed by ROCSCIENCE Inc., Toronto, ON, Canada, in conditions of limit equilibrium, according to the Janbu method [31]. The analysis was performed for the case of a reconstructed TSF, which was upgraded with material from the cleaning of agricultural land in the downstream area, under conditions of static load, earthquake load, and earthquake load, with liquefaction simulation. Table 3 shows the calculated stability factors (Fs) and the interpretation of their value according to SRPS U.C5 Standard and Guidance on Geotechnical and Stability Analysis [32,33].

Based on the obtained results of the stability analysis, it can be concluded that the TSF is stable in static and dynamic conditions. These data provide a good basis for risk assessment of another accident at the TSF of the "Stolice" mine. If the 3 × 5 risk assessment matrix is taken into account, the probability of an accident based on the obtained results of the stability analysis can be assessed as "low". The significance of the consequences is equated with the significance of the already-recorded consequences of accidents from 2014, when they were assessed as consequences of "low to high" significance. Based on these two parameters, a "low-to-medium" risk level, ranked between 1 and 3, is obtained, which is interpreted as an acceptable risk [34] (Figure 10).

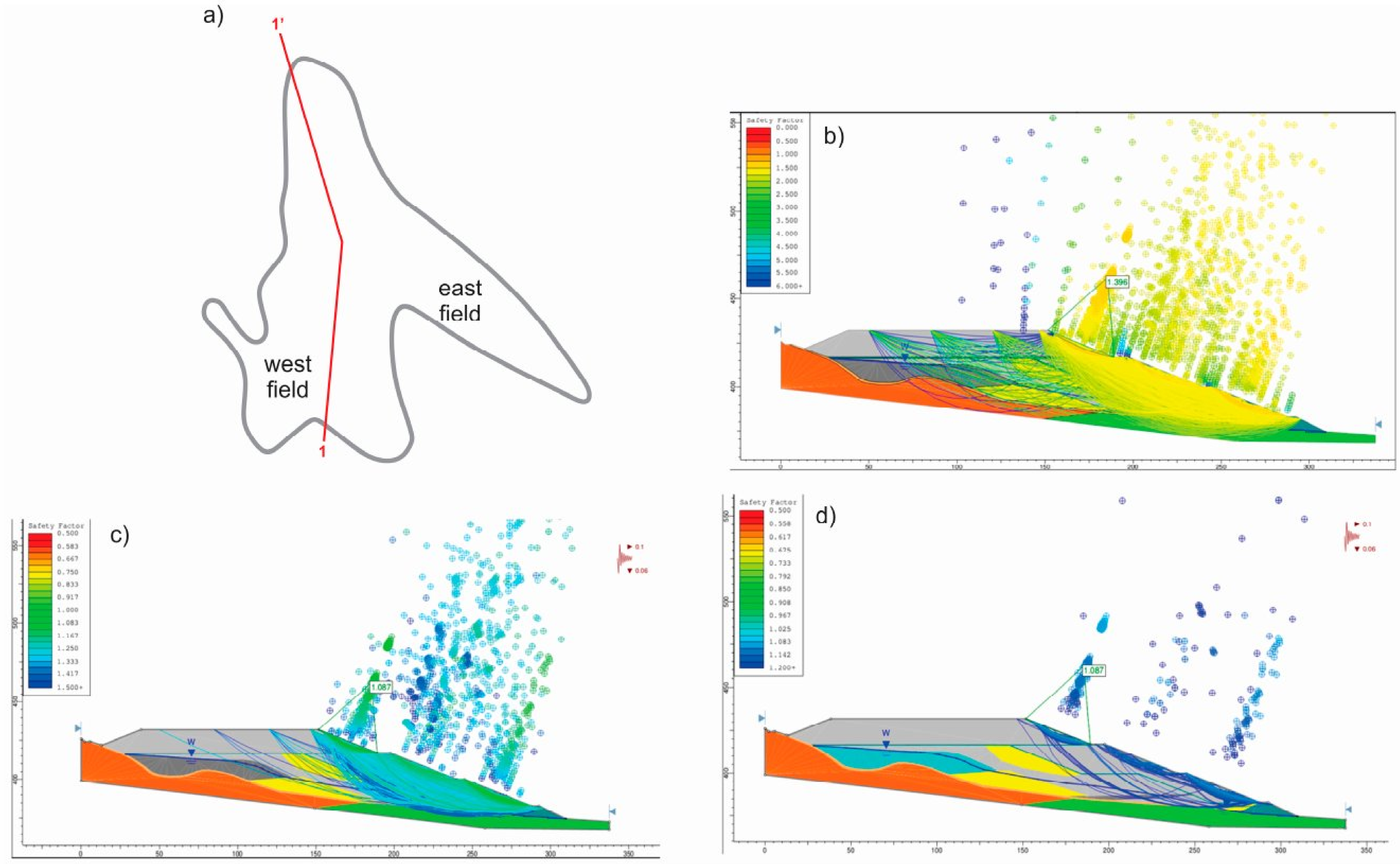

Figure 9. Stability analysis of the reconstructed TSF: (**a**) position of the profile used for analysis; (**b**) result for static load; (**c**) result for earthquake load; (**d**) result for earthquake + liquefaction load. Reproduced with permission from the Water Institute "Jaroslav Černi" [11].

Table 3. Stability analysis results.

Load Type	Fs [11]	Meaning
Static	1.396 (Figure 9b)	Acceptable Fs. TSF can be considered long-term stable [32].
Earthquake	1.087 (Figure 9c)	Acceptable Fs. TSF can be considered long-term stable [32].
Earthquake + Liquefaction	1.087 (Figure 9d)	Acceptable Fs. TSF can be considered long-term stable [33].

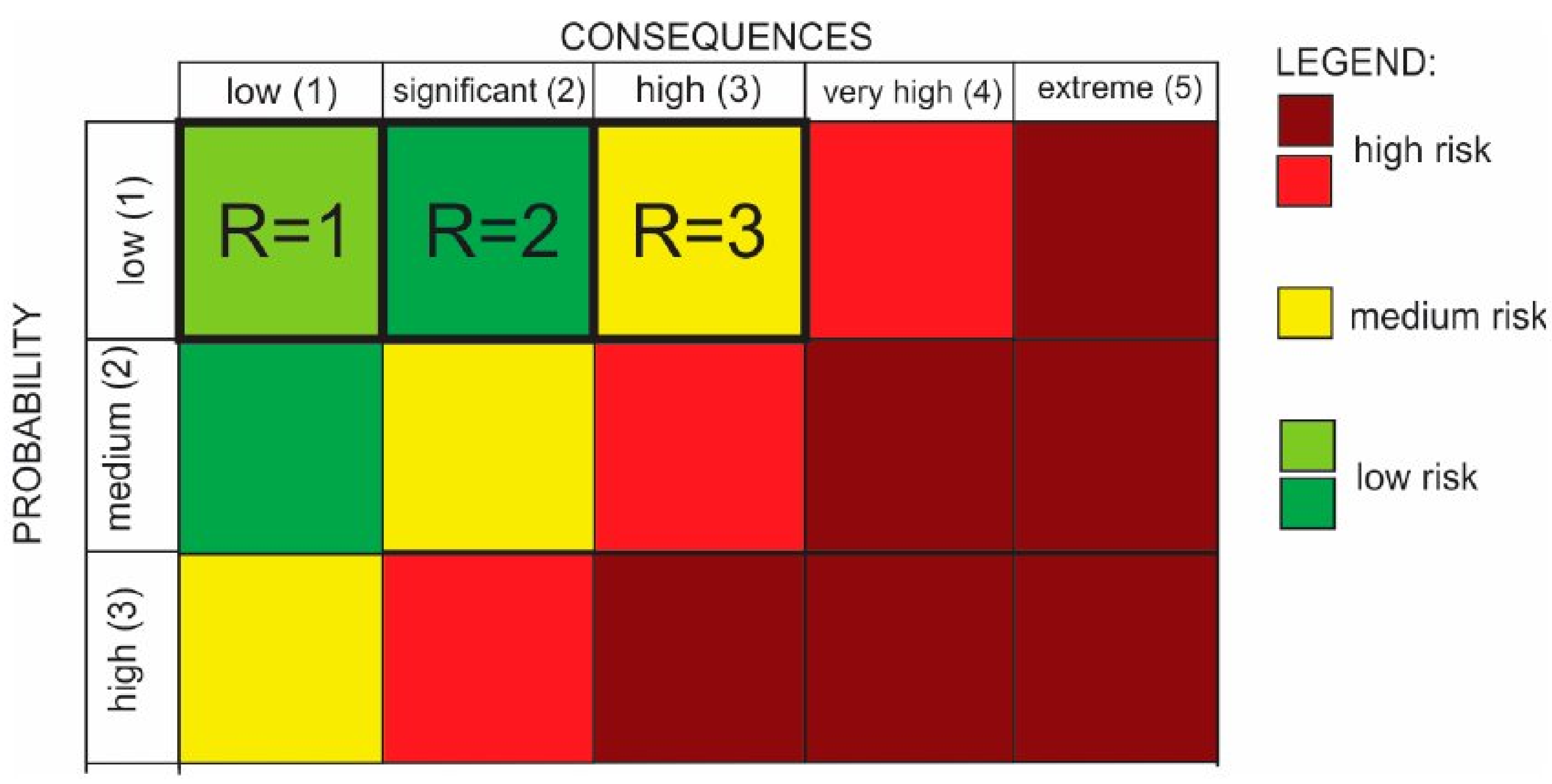

Figure 10. Risk matrix 3 × 5.

8. Lessons Learned

Although inactive landfills such as the flotation TSF of the "Stolice" mine are considered to have up to five times less accident potential than active landfills [35,36], accidents still occur, and they can be large-scale. The upstream method by which the TSF was built makes it particularly fragile to filtration disturbances in cases of inflow of a large amount of water [5]. This review emphasizes the importance of learning from past accidents to improve safety and prevent future occurrences.

The main lesson of the accident that may be stated is that no TSF may ever be neglected. Every TSF, whether active or inactive, requires the following:

- Regular monitoring, which includes visual inspection and specialist measurements of parameters to assess stability. The only difference between the monitoring of active and inactive TSF is in the frequency; in the case of inactive TSF, it is carried out much less often [5].
- Regular remediation if monitoring has established any damage to the TSF.
- Regular accident risk assessment, which could indicate the potential of an accident and its potential consequences in a timely manner, and which has only been prescribed as a legal obligation within the Mining Waste Management Plan since 2020 [37].
- Regular innovation of legislation in the field of mining waste management in order to establish strict and regular control of mining companies with the aim of encouraging them to responsibly manage their tailings.

9. Conclusions

As an entire decade has passed since the accident at the flotation TSF of the "Stolice" mine, enough time has been provided to draw conclusions from this unfortunate event. Judging by the condition of the TSF, even before May 2014, when the accident occurred, the TSF was not well maintained. According to the Serbian Landfill Directive [38], the owner of the TSF is obliged to observe and monitor the TSF for 30 years after closure, while according to the Standard for Responsible Mining v.1.09 of the Initiative for Responsible Mining Assurance (IRMA), that the period should last a minimum of 25 years and, if necessary, even longer [39]. This means that the owner is solely responsible for the neglect of the TSF of the "Stolice" mine. The period of additional monitoring of the TSF after closure cannot be defined in advance because it depends on the TSF's specific state and events on the field; however, it is clear that in this case, there was not even a mandatory one-year visual control of the state of the TSF because if there had been, the accident might have been prevented. Only at the end of the closing phase and the mandatory monitoring after the closure of the TSF, i.e., the activities and obligations of the owner end. The closed TSF is handed over to the local self-government and the surrounding population for further management and use [5]. Also, according to the condition of the TSF before the accident, it can be concluded that it was not adequately closed and recultivated with the recommended multi-layer covering [39,40], which would guarantee its physical, chemical, and biological stability [41]. The reason for these omissions probably lies in the fact that the last owner of "Farmakom MB" was "handed over" the TSF, which, at that moment, had been inactive for 16 years, but that certainly does not diminish their responsibility. Although some initial remediation measures were implemented shortly after the May accident, which turned out to be inadequate as the temporary barriers on the east field were breached again in July of the same year, actual and project-based remediation did not begin until 2 years later in 2016.

Fortunately, according to the GISTM, the consequences of this accident are between low and high, i.e., a rank of 1–3 out of a maximum of 5, which indicates that the accident was not catastrophic, with consequences on a global scale; the consequences were only local. This gives hope that the damage can be repaired in the future. Although of a local nature, without consequences on a catastrophic scale and a large number of human casualties, such as in the case of the accidents that occurred in Brazil at the Fundao tailings storage facilities in 2015 [42] and the Brumadinho TSF in 2019 [43], it can be stated that the accident at the flotation TSF of the "Stolice" mine is one of the biggest environmental accidents at the flotation tailings storage facilities in Serbia in the last 20 years.

Remediation efforts, conducted in phases, included cleaning riverbeds and agricultural lands, rebuilding infrastructure, and re-profiling the TSF to prevent further damage. According to the stability analysis of the reconstructed TSF, it is concluded that the TSF is now stable and risk of new failure is low-to-medium, with rank of 1–3, which is acceptable.

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