Massive alumina red sludge release after the failure of a containment dam

4 October 2010

Kolontár

Hungary

red sludge
aluminium
tailings dam
collapse
transboundary effect
water pollution

THE FACILITIES INVOLVED

The site :

The aluminium plant of the Hungarian Aluminium Inc. (MAL Inc.) is located in Hungary around 100 km south-west of Budapest in the surrounding area of Ajka town.

MAL Inc. is a 100% private owned aluminium producing company established in 1995 at the time of the privatisation of the Hungarian aluminium industry. The company became the owner of the formerly state owned plant that has been in operation since 1942. During the privatisation the company managed to get involved in all sectors relevant to aluminium production (bauxite mine in the Bakony, alumina plant in Ajka, aluminium smelter in Inota). 75% of the company's products are exported to Western Europe. The MAL Inc. has been active in neighbouring countries (Slovenia, Romania, and Germany) with the purchase of companies with related profiles.

1. Location of the site

The involved unit :

The MAL Inc. and its predecessors placed the red sludge into tailing ponds in the Torna Creek's valley between Ajka and Kolontár. Between 1943 and 1968 the red sludge was brought to Reservoirs 1-4 inside the premises of the factory. After 1967 six new reservoirs (5th -10th) were built west from the factory. The Reservoir 10, where the accident occurred has been in use since 1998.

The factory is located on a 49,11 hectare land, and the reservoirs cover a further 207 hectares. Reservoir 10's volume is 4.500.000 m3 and its base is on 19 hectares. The height of the dam walls is between 21-25 metres, and the width is 10 metres at crest.

2. Satellite view of the Reservoir 10 and Kolontár before the accident

THE ACCIDENT, ITS CHRONOLOGY, EFFECTS AND CONSEQUENCES

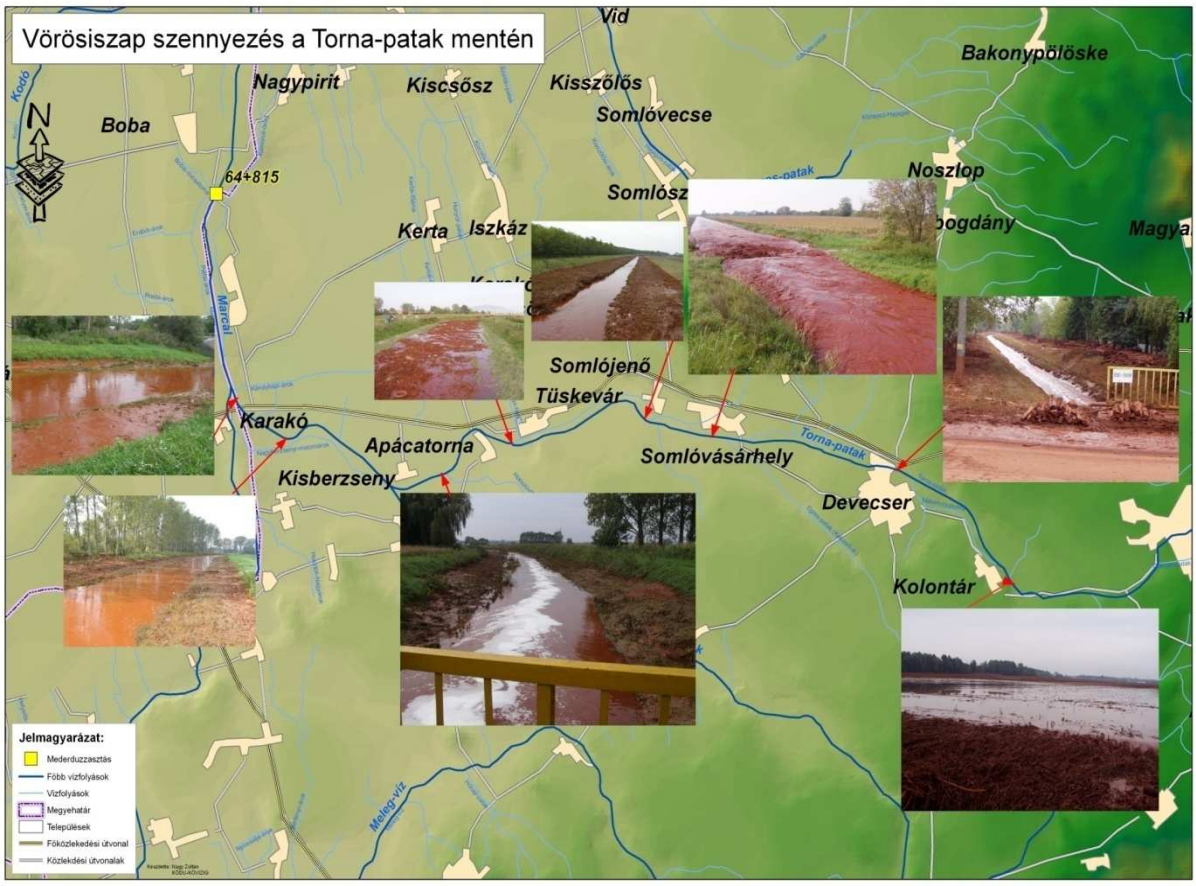
The accident :

At around midday on 4 October 2010 a breach occurred in the dam wall (app. 50 metres long) holding back red sludge in containment Reservoir 10 of the MAL Inc. The strongly alkaline water produced through the Bayer process for the treatment of bauxite, containing resides of aluminium and toxic metals immediately flooded the village of Kolontár, then Devecser and other towns. Instant response was necessary to protect lives and property, and to preserve natural assets and agricultural areas.

The red sludge itself is a residuum of aluminium production. Around 24-45 percent of the red sludge was ferrous oxide, other metallic compounds (aluminium oxide, titanium dioxide, silicon dioxide, sodium oxide and calcium oxide) were also contained, and less than one percent was rare earth metal oxides. The red sludge also contained sodium hydroxide, which is a caustic base.

As the result of the rupture of the dam wall, the Torna Creek and its valley were contaminated by the estimated amount of over 1 million m^3 of alkaline red sludge. The pollution plume reached the Marcal River at 6:00 pm on the same day, in which the recent flood wave was already decreasing, therefore the transport of the pollution fortunately slowed down. In the morning of the 5 October a warning message was sent out to the Danube basin countries by Hungarian national centre (PIAC) through the Accident Emergency Warning System (AEWS) of the Danube Protection Convention. The head of the plume passed the village of Mersevár at 3:00 pm on the same day.

3. Dike breach



4. Contamination along the Torna Creek

For the mitigation of the environmental damage, the Environmental and Water Directorates involved (Székesfehérvár, Szombathely, Győr) ordered emergency preparedness state on the same day. From 4:00 pm on 4 October the highest alert (level III.) has been in force along the Torna Creek and Marcal River on a total length of 92.3 km.

At the Governmental Coordination Committee meeting held at 4:00 pm on 5 October 2010, decision was made about the immediate reconstruction of the levee of the tailing pond and about the further treatment of the residues of red sludge in the area.

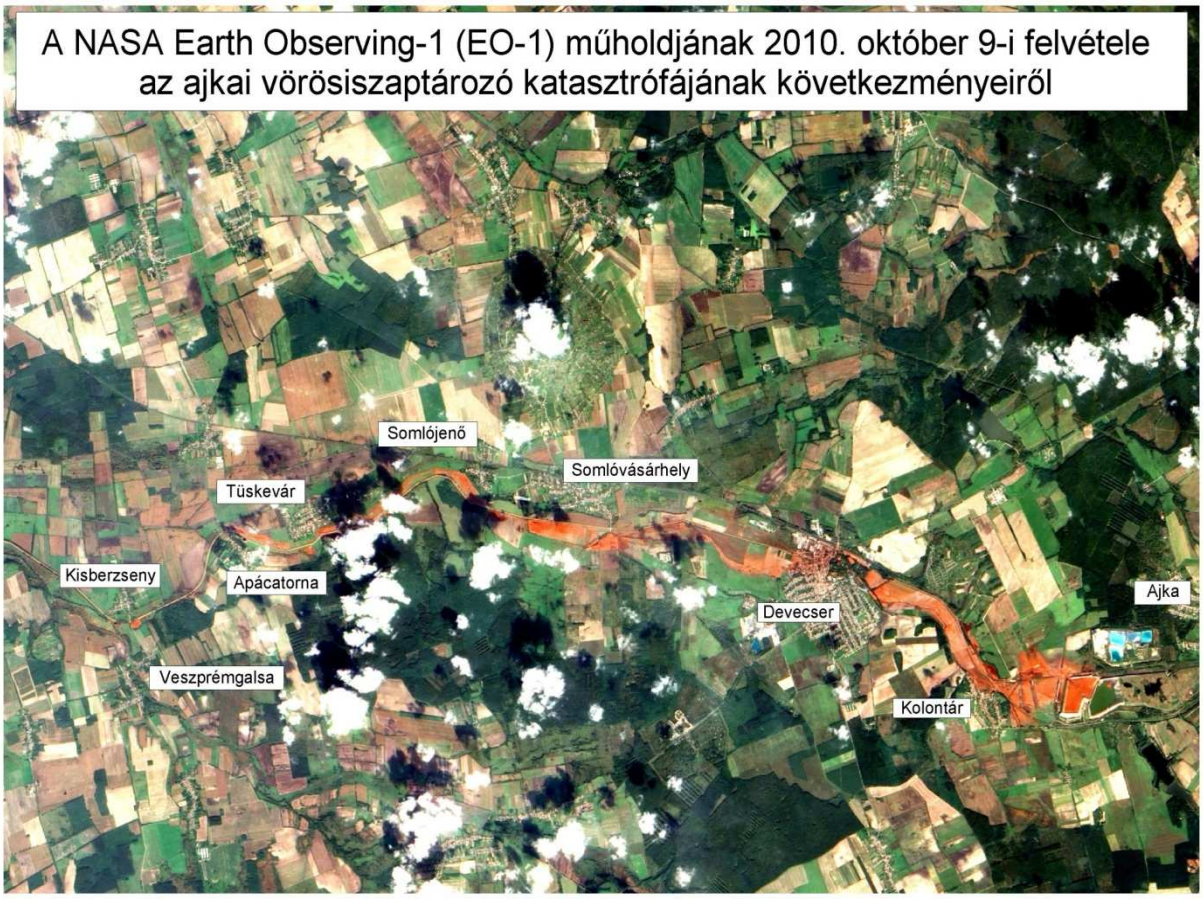
In the framework of the mitigation activity in order to reduce the alkaline effect, gypsum has been spread since the morning of the 5 October in the village Kolontar, later in Devecser and Somlóvásárhely as well as into the Marcal River at the bridge between Szergény and Vinár. The spread of the material was later continued from aeroplane. At the downstream section of the Marcal River (at 22 river km) gypsum–depot was created at Mórichida. Water jets were used to increase efficiency of the mixing of the gypsum and the pollutant.

Hungary took intensive measures on the whole length of the Marcal River before the arrival of the pollution plume to settle down the suspended solids possibly contaminated by heavy metals. For this reason decision was made to construct 7 so called “riverbed barriers” (artificially created obstacle under water – on the river bottom - to stop the heavier fractions of contamination (the red mud) in the riverbed).

5. Riverbed barrier

In order to reach a tolerable level of pH, an intensive neutralisation process was going on at the end-section of Marcal River (upper of its confluence). It was achieved by neutralisation effect of bio-acetic-acid. The water reached the Danube after further dilution process in the Raba and the Mosoni-Danube Rivers only, where neither water quality problems nor harmful to health effects were detected. Consequently Hungary could successfully avoid severe alkaline and heavy metal pollution of the Raba and Danube rivers.

The Hungarian State’s priority aim was to keep the pollution plume inside the territory of the country, to localize the mud in the Marcal river bed and to prevent pollution plume to reach the Danube River via Rába River and Mosoni Danube.



6. Satellite image of the area (9/10/2011)

The effect and risk of the dust-polluted air was continuously controlled by the environmental agency and the public health institute. The risk communication was represented by the Government and the Ministry for Interior.

Consequences of the accident :

The accident was the most severe industrial catastrophe in Hungary's recent history, with 10 fatalities, 286 injured persons (121 required treatment in hospital) and major environmental and economical damages. There were 51 houses in Kolontár, 275 in Devecser and 39 in Somlóvásárhely damaged by the red sludge, and 1017 hectares of soil contaminated. 284 houses were irreparable and must have been demolished. Also the Torna Creek's and the Marcal river's ecosystems were seriously affected. The main issue were the incredibly strong flood wave and the strong caustic effect.

As we are still in the time of constant interventions, long run impacts cannot be estimated accurately.

The European scale of industrial accidents :

By applying the rating rules applicable to the 18 parameters of the scale officially adopted in February 1994 by the Member States' Competent Authority Committee for implementing the '*SEVESO II*' directive on handling hazardous substances, and in light of the information available, this accident can be characterised by the four following indices:

Parameter Q1 is 1, as the red sludge was not considered hazardous material

Parameter Q2 is 1, no explosive substance was involved

Parameter H3 is 6, 10 casualties, but all persons from the public

Parameter H4 is 6, 121 hospitalised mostly persons from the public

Parameter H5 is 6, over four hundred injured were treated by medics on sight

Parameter H6 is 6, 365 houses and other buildings were damaged

Parameter H7 is 6, as initially over 800 residents were evacuated, many of them couldn't return as their houses must have been torn down due to heavy damages

Parameter H8 is 2, there were just minor interferences with the public utilities

Parameter H9 is 6, as all residents and rescue personnel must attend regular health checks since then, as recommended by the World Health Organisation

Parameter Env10, Env11 there is no data available, assessments are still in process for estimates, but no results yet

Parameter Env12 is 6, as over 10 million m^3 of water was contaminated

Parameter Env13 is 6, around 1000 hectares were contaminated

Parameter E17 is most likely 6, but there are no accurate estimates available to specify concrete sums

Parameter E15, E16 and E18 cannot be determined properly yet as the assessments are not finished

The parameters composing these indices and their corresponding rating protocol are available from the following Website : http://www.aria.developpement-durable.gouv.fr

THE ORIGIN, CAUSES AND CIRCUMSTANCES SURROUNDING THE ACCIDENT

On the 4 October 2010 at 12:30 the western dyke of the Reservoir 10 broke and approximately 1,000,000 m^3 of red sludge and alkaline water flooded the lower parts of Kolontár, Devecser and Somlóvásárhely through the Torna Creek.

At the time of the accident the aluminium factory still used a so-called wet technology, which was quite outdated and resulted in producing the red sludge during the production process. It must be highlighted that the tailing ponds did not simply function as waste containers, but they were part of the production process (the liquid phase was reused from the tailing). That is the reason why not only the solid and otherwise quite harmless red sludge was in the reservoir but also a considerable amount of alkaline water. During the production the alkaline was collected and deflected back through a tube system into the factory for further use.

One of the reasons that led to the accident was the extreme amount of rain in the year 2010. It was the source of numerous agricultural and environmental problems all over Hungary in that year. The extreme quantity and the intensity of rain resulted in huge agricultural areas covered with inland waters and caused floods in some areas where it was unprecedented before. The enormous amount of rain that fell on the top of the red sludge in the Reservoir 10 further increased the pressure on the wall of the dam. It worked as a catalyst in the dike's erosion process and finally led to the breach of the wall.

The reasons behind the fatalities and the injuries of the accident came for two different sources. First of all the weight, the speed and the amount of the flood waves pouring out of the reservoir was the cause of the casualties and traumatic injuries. It was also responsible for the physical damages of the houses, roads and the railways. The alkali mixed with water and the sludge was responsible for the high pH level of the mixture, which resulted in chemical burning injuries and chemical damages on property.

ACTIONS TAKEN

According to the severity of the accident rapid action was required from the Hungarian Government, with the joint actions from the Ministry of Internal Affairs, the National Directorate General for Disaster Management and the Ministry of Rural Development. The exemplary work of the local population, local councils, civil defence organisations, the fire department, environmental protection activists and hydrological experts must be highlighted.

Immediately after the accident the Official Fire Department of Ajka arrived to the scene with 84 men in 12 vehicles. They were followed by further 103 policemen with 22 vehicles, 174 soldiers with 43 vehicles, 41 officials of the directorate for disaster management with 20 vehicles, five persons from the from the public health service with 2 vehicles, 149 civilians with 43 vehicles and 50 workers of the MAL Inc. In November 2010 all together 8535 persons and 4881 technical devices worked at the scene of the accident.

Assessment of water quality in the area began immediately: measures were taken of the water temperature, pH values, specific conductivity and levels of dissolved oxygen, and water levels monitored continuously. The assessment included evaluation of general water chemistry, toxicity and metal content.

Over the course of four days (9-12 October) teams of construction professionals built a defence dam (Dam Number 1) 620 metres long, 2.75 metres high and 6.8 metres wide near the ruptured sludge container. After constructing the defence dam, hydrological experts began work on temporarily sealing Reservoir 10. The breach has been completely closed with tiered ring dam walls with water outlet capacity. The six cascade basins formed by the ring dams safely drain alkali water from the damaged reservoir, while holding back red sludge.

From the end of November until the end of December the permanent defence dam (Dam Number 2) was built with 1,300 metres in length and 4.5 metres height. Along the entire length of the base of the dam wall a waterproof barrier wall was built, extending down below the ground surface to the base stratum of clay (6-9 metres)

Protection of water quality also demanded immediate action. The most important measures were neutralisation of water and the capture of floating matter containing heavy metals. Gypsum (23,500 tonnes) and acetic acid (cc. 1,800 m^3) were used to reduce water pH levels. The mixing of gypsum as it began to be applied was aided by the use of high-pressure fire-hoses and aeration equipment. In the settlements involved gypsum was also added directly on affected areas.

7. Decontamination (gypsum dispersion, below Kolontár Bridge)

In order to capture solid pollutants, so-called “riverbed barriers” were constructed on the River Marcal, the Torna Creek and the Malom ditch. The deposit of boulders in water slowed down the flow of water – reducing it to a third of its previous speed in places – and caused sedimentation of harmful red sludge.

As the sludge destroyed and permanently damaged many houses in Kolontár, Devecser and Somlóvásárhely, there was a need to help the owners of the real estates, as they suffered a great loss. Considerable amount of dedication was shown, as the Hungarian Government, NGOs, companies and individuals offered their financial and material support. A lot of help was received from abroad as well.

The red sludge also flooded around 400 hectares of agricultural land. Because of its high pH level and high percentage of metallic compounds these fields were seriously damaged and became incapable to produce healthy farm products. The top two centimetres of the soil was cleared and remediated everywhere in the affected area. The more heavily contaminated soil was cleaned up and brought to an officially designated dumpsite (cc. 730.000 m^3). In those areas where the contamination did not affect the soil so significantly, the agricultural authority (soil conservation service) decided to use acidifying organic soil improvers i.e. “dudarit” (humic mineral) to neutralize the alkaline and improve the soil function.

As planting for human or animal feeding is still not permitted, rehabilitation of the contaminated land is continuing with the cleanup processes, using the above mentioned organic soil conditioners and soil fertilizers, and with the cultivation of “E-grass”, plant that is less sensitive than other crops and is a major source of renewable energy. The strategy of the Hungarian Government in order to help to recover the area is to establish a centre for renewable energy with energy plant fields. This would create jobs and provide the surroundings with sustainable energy.

The MAL Inc.’s IPPC permission was issued in 2006, and was valid until 28 February 2011. The company had to shift to the use of the dry technology in order to receive the new permit for further five years. As a result the pH level of the

residuum decreased from 13,6 to 10 and the percentage of water from 75% to 25-30%. This means that the red sludge is less liquid and less alkali, therefore the chance of a similar accident has significantly decreased.

The accident in Kolontár showed the risk, what the remedies of mining sites were representing, that is why the Hungarian Government decided to run a grand scale assessment on the operating mining waste deposition sites. All the relevant authorities were involved throughout the country and they had to report on their findings. The assessment of the reports is still not completely finished but all necessary measures have been taken to prevent another accident.

As the damages caused by the accident proved to be major, the Hungarian government decided to establish a financial fund in order to help financing the reconstruction of the destroyed villages and homes. It was called the Hungarian Compensation Fund. There was a massive dedication shown from Hungarians and foreigners who helped the people involved through this fund.

LESSONS LEARNT

According to the severity of the catastrophe, extensive investigations were trying to assess the causes of the accident, and also the question of responsibility. The accident was the subject of an investigation by a Committee of the Hungarian Parliament, the National Investigation Office, the police and the Parliamentary Commissioner of Future Generations (Ombudsman). Also civil law and criminal law proceedings are on-going in front of the Hungarian courts regarding responsibility. As most of these investigations and legal procedures are not finished at time of writing (June 2011), official conclusions are not yet available.

The investigation of the Ombudsman of Future Generation was concluded in January 2011, and so far this is the only relevant evaluation of the accident. The main focus of the Commissioner's analysis was on the legal environment of the factory, and what were the deficiencies of the permission and supervision process of the aluminium factory.

As the investigation of the Ombudsman has already noted there were some legislative loopholes regarding mining waste in the Hungarian legal system. After the incident the Government analysed the relevant regulations, and as the result of this investigation amendments were accepted to the current laws and decrees. These changes clarified the situation of the mining residues and by-products and also managed to ensure the better implementation of the relevant EU law. As a result the legal situation became clear, and now the District Mine Inspectorates are the responsible authorities in the cases of the tailing ponds.

The EU asked the former Hungarian government to no effect to clearly stipulate the responsible authority for such units before the accident occurred, but it never happened. The current Hungarian government had to deal with the situation, and after the necessary assessments and legislative measures were taken, the task was assigned to the District Mine Inspectorates.

The accident in Kolontár also highlighted, that the regulation in the European Union regarding the red sludge is not exactly clear. Hungary initiated the amendment of the relevant EU law. According to the Hungarian proposition if the red sludge is not the result of the dry technology, but the residuum of the wet method, then it should be labelled as hazardous waste. At the time of the accident it was not clearly stated, but there was a possible choice between hazardous and non-hazardous waste.

The case confirmed the high level of risks of the tailing dikes and the unpreparedness of the MAL Inc. for a catastrophic situation. The company had a damage prevention plan, but it was designed for a much smaller scale of accident (i.e. leakage or overflow of the reservoir) and not a catastrophe where the inhabitants of the area can be threatened.

In order to better avoid the problems resulting from such an accident, the Hungarian government realised it must be compulsory for all companies who are dealing with hazardous material to have insurance covering for such incidents as well.

Since the accident the Hungarian Government lost no time to act (securing the site and the townships involved, intensify authorities supervision, revise legislation concerned, etc.) in order to lower the risk of another incident like this happening again to a minimum.