MAIN FINDINGS AND RECOMMENDATIONS FROM THE WHO/EUROPE MISSION TO HUNGARY

12 -16 October 2010

INTRODUCTION

The Regional Office for Europe of WHO deployed an international team to Hungary from 12 to 16 October 2010 to support the Hungarian Government in dealing with the medium- and long-term health effects of the spill at the alumina plant Magyar Alumínium Zrt. (MAL Zrt.) Ajkai Timfoldgyar in the town of Ajka. The mission complemented the technical team of the European Union already on location, and in particular focused on public health aspects

The team presented its preliminary findings and recommendations to the Hungarian Ministry of Natural Resources, to the National General Directorate for Disaster Management and representatives of the Hungarian Governmental Coordination Committee and to the National Institute of Environment and Health on Friday, 15 October 2010.

Overview of recommendations

From rescue operations to recovery and rehabilitation

1. MINIMIZE EXPOSURE OF RESCUE WORKERS
2. MINIMIZE EXPSOURES OF RETURNING POPULATIONS

Medium and long term impacts

3. MONITOR AIR POLLUTION
4. PRESERVE AND CONTROL THE QUALITY OF DRINKING WATER
5. MONITOR SOIL QUALITY AND CHECK SAFETY OFLOCALLY PRODUCED FOOD
6. COMPLETE THE CHEMICAL CHARACTERIZATION OF REPRESENTATIVE SAMPLES OF SLUDGE
7. CLARIFY REMAINING UNCERTAINTIES REGARDING THE.SLUDGE RESERVOIRS

Trans-boundary effects

8. ADDRESS ASPECTS OF TRANSBOUNDARY RELEVANCE

9. ENSURE THAT COMMUNICATION TO THE PUBLIC REMAINS TIMELY AND ACCURATE, USING AVAILABLE EXPERTISE FROM HEALTH INSTITUTIONS AND THE NATIONAL ENVIRONMENT AND HEALTH INSTITUTE, AS APPROPRIATE.

10. STRENGTHEN COORDINATION OF EMERGENCY PLANS AND PREPAREDNESS

Acknowledgements

The WHO/Europe team is extremely grateful for the excellent support received throughout the mission from the National authorities, in particular the Ministry of National Resources; the Hungarian Academy of Sciences, the National Public Health and Medical Officer Services, the National Institute of Environment and Health, the National Institute of Occupational Health, the National Directorate of Disaster Management, the management of the Bakonykarszt Viz és Csatornamű plc. water supply and sewage company.

Team members

The WHO mission was composed of

- Mr Bruno Frattini, industrial risk assessment risk management specialist, Italy
- Dr David Russell, Consultant in Environmental Toxicology, WHO-Collaborating Centre for Chemical Incidents, United Kingdom.
- Mr Roger Aertgeerts, water, sanitation and health specialist, WHO/Europe
- Ms Francesca Racioppi, Head of the Rome Office a.i. WHO/Europe

The team had international expertise in evaluating and managing the risks to public health from environmental exposures, in particular from contaminated water and chemicals.

The mission was supported by the network of WHO Collaborating Centres and expert roster in other disciplines, as well as by relevant WHO technical programmes.

The mission was locally supported by Dr Zsofia Pusztai, Head of the WHO Office in Hungary.

Technical support was provided by WHO staff in the WHO Regional Office for Europe (Dr Michal Krzyzanowsky, Dr Rokho Kim, Mr Matthias Braubach) and WHO Headquarters (Joanna Tempowski).

The contribution of the following international experts is also gratefully acknowledged:

- Otto Hanninen, National Institute for Health and Welfare (THL), Kuopio, Finland
- Georg Houben, Federal Institute for Geosciences and Natural Resources Germany
- Bruno Frattini, ICARO srl, Cortona, Italy
- Michael Pugh, expert in personal capacity
- Xavier Querol, Instituto de Ciencias de la Tierra "Jaume Almera", Barcelona, Spain
- Philip Rushbrook, International Directorate Home Office United Kingdom
- David Russell, WHO Collaborating Centre for Public Health Management of Chemical Incidents, Cardiff, United Kingdom
- Adrea Rechenburg, WHO Collaborating Centre for Health Promoting Water Management and Risk Communicationb, Bonn, Germany

Scope of the mission

The WHO mission's goal is to support the Hungarian authorities, and work in a coordinated manner with the EU team of experts, with the following goals:

- Assessing immediate and medium-term health and environmental risks of the remaining sludge, and identification of health and environmental risks in clean-up of the affected areas
- Assessment of immediate and medium-term health effects of exposure to air contaminants, including effects due to air transport of contaminants
- Assessment of immediate and medium-term health effects of water contaminants
- Preliminary assessment of long-term health implications of the spill

Main findings and recommendations

1. Affected population and acute health impacts

- The affected population consists of people living in the areas directly affected by the sludge: Kolontar, where some 40 houses have been destroyed or severely damaged by the flow of red sludge; and in Devecser and Somlóvásárhely in western Hungary where some 260 houses have been damaged to a varying degree. Number of residents in the area, by age and sex, is given in Annex 2.

- Approximately 4000 workers and volunteers employed in rescue and rehabilitation operations were also affected.

- Direct immediate effects of the event were serious but localized, with 9 people killed and over 150 injured., mostly due to **severe injuries** and **chemical burns** caused by the elevated pH (above 12) of the red sludge, which has a corrosive effect on the skin and eyes. After the initial emergency phase, **minor casualties** were reported particularly among the rescue workers, who presented to local GPs with either physical injuries from working on site or symptoms of mucosal irritation, in particular eye irritation.

- As the sludge receded and its pH decreased, potential for direct health damage from contact diminished substantially. At the affected sites, measures were taken to neutralize the sludge and reduce the immediate danger of exposure to the corrosive mud. Concomitantly, the number of individuals presenting to local GPs with symptoms decreased significantly.

- **Psychological effects** are also recognized. Stress, anxiety, sense of loss and post-traumatic stress disorders are reported by some community members, particularly those who were evacuated, and suffered personal and family injuries, loss and damage to housing and property. A specialized crisis intervention team is available on site to provide psychological assistance, and this kind of support is likely to remain necessary in the short to medium term.

- The team noted with satisfaction that **the main drinking water supply and quality has remained adequate for the needs of the community**. The supply has also met the increased need for water related to the on-going cleaning and watering needs.

2. From rescue operations to recovery and rehabilitation

- Removal of the sludge from streets and house gardens and orchards is underway, and its safe collection, transportation and disposal is of importance, to minimize exposures and dispersion of dust and particulate matters.
- Continued attention needs to be paid to the occupational health of the teams of workers and volunteers performing the cleaning-up of the affected sites. In particular, measures have to remain in place to reduce exposure by contact, inhalation or ingestion of the sludge as well as dust, during on-going operations of

treatment, removal and transportation of sludge and debris and use of rolling vehicles.

RECOMMENDATION 1 - MINIMIZE EXPOSURE OF RESCUE WORKERS

- Workers and their managers should be trained on key measures in hazard prevention and control. Workers representatives should participate in this training in order to ensure compliance, dissemination and acceptance.

- All workers should be provided with the appropriate tools, equipment, personal protective equipment (PPE) and protective clothing needed to perform their job tasks safely. Workers should be trained in the appropriate care and use of this equipment. PPE should be selected based on identification of the hazards, protective qualities (such as alkaline dusts and heavy metals) and suitability for the tasks performed. The local Occupational Health experts should decide whether special protection is needed such as special respirator masks against alkaline and heavy metals. PPE needs to be appropriate to prevent direct dermal contact with the sludge and to provide adequate respiratory protection against the agents likely to be encountered.

- In addition, in order to prevent irritation to eyes and skin, there is a need to avoid contacts between hands and eyes, mouth and nose. Therefore, good hygiene is mandatory. When protective gear is removed, skin should be rinsed with plenty of water to reduce the risk of irritation. At the end of shifts, it is advisable to shower, and wash clothes. Rest breaks and meals should be taken in relatively cleaner areas, away from the site of operations.

- Enforcement of safety and protective measures needs to be ensured by all working on site, regardless of their status (employed, owners, voluntaries) and their affiliation.

- Red mud and contaminated soil needs to be transported in covered vehicles to minimize exposure of workers and reducing exposure of population along the transportation routes.

RECOMMENDATION 2 - MINIMIZE EXPSOURES OF RETURNING POPULATIONS

- Temporarily displaced population need to be advised about options available to them regarding the safe return home, relocation, refurbishing of damaged houses or compensation, as uncertainty in this essential matter is a major source of stress and frustration. Timely communication from credible channels is important to address these important concerns.

- The return of evacuated population to their homes should only take place following remediation and clean up, coupled with exposure assessment (e.g. to polluted air), as well as assessment of conditions that could increase the vulnerability of some individuals, such as children, pregnant women, elderly and people with pre-existing conditions (see Annex 3 for details).

- Red sludge removal and cleaning up operations should be completed by professionals. Drying up operations in homes should also be done by professionals, as excess ventilation (one of the simplest measures usually taken) may increase the amount of dust and particles being airborne, and spread them around the dwelling.

- Air pollution measurements in affected houses should be undertaken prior to return with a focus on assessing concentration of particulate matter. In cases 24h mean PM10 exceeds 100 µg/m3, the reasons for such high pollution level should be investigated and removed. At all times, precautions should be taken to minimize exposures of vulnerable groups, such as children, pregnant women, elderly people and people with pre-existing conditions (see Annex 3). Such measurements should be conducted in a sample of houses, chosen randomly but representing, as much as possible, the variable extent of contamination.

- It is recommended to undertake systematic monitoring of indoor air (by portable gravimetric monitors enabling elemental analysis of particulate matter) located for 24-48h in selected houses. Gravimetric collection of particulates also lends itself to the possibility for analysis of heavy metals. Sampling could take place in the most commonly used rooms, e.g. living rooms and bedrooms (if feasible: monitoring equipment is noisy). The houses would subsequently need to be periodically inspected by trained inspectors for dampness and associated mould growth.

- On a precautionary basis, and with views of promptly identifying any unexpected risk (e.g. of allergic reactions), an effective system of periodic health screening of general health status, reporting and investigation of unexpected symptoms should be organized, with a special focus on vulnerable population groups. Population should be informed of these programmes and encouraged to participate on a voluntary basis.
  Returning population should receive practical advice (e.g. through leaflets and web sites) about precautions that could be taken to minimize exposures (see Annex 4 for details).

3. Medium and long term impact

- The accident may have resulted in widespread contamination of the environment, including air, water, soil and food products in the affected area. Therefore, potential medium and long term health impacts from direct contact with sludge from exposure to airborne particles and potential contamination of locally produced food and drinking water needs to be evaluated in order to assess potential risks of exposures.

- On the basis of the first round of assessments in this respect, the necessity for programmes of targeted biomonitoring of affected people should be assessed, in order to measure the actual extent of human exposure and to validate model-based risk assessments.

Air pollution

- Airborne particles from dried sludge could contribute to a higher exposure through inhalation of contaminated dust. The alkalinity of dust could cause mucosal irritation and thus respiratory, nasal and ocular symptoms. The application of spray of magnesium calcium acetate may be effective in agglomerating particles and reduce re-suspension when drying, thereby reducing the risk of deep inhalation. Loading of sludge during removal operations should be preferably performed at night to avoid diurnal convective conditions and reduce population exposure.

RECOMMENDATION 3 – MONITOR AIR QUALITY

- Monitoring of ambient air in the villages is essential to avoid that the risk of dust exposure be underestimated.

- Automatic monitoring of particulates (PM10, PM2.5 and PM1) to ensure assessment of temporal distribution of various PM sizes as well as gravimetric samplers for PM10 and PM2.5 with filters periodically analyzed for heavy metals is recommended.

- Monitoring equipment should be located in fixed locations in the center of residential areas and in the proximity of properties exposed to the sludge. Besides particulates, NO2 and CO should be monitored – these will act as proxies for traffic pollution. Elemental analysis of PM analysis should be able to identify key heavy metals contained in the sludge (in particular Cr VI). The alkalinity of the dust should be assessed to estimate risk for possible irritation following the contact between the caustic dust and the moisten surface of the respiratory apparatus. WHO is supporting the identification and selection of appropriate methodologies for the characterization of chemical composition and alkalinity of the sludge.

- Obtain measurements of air quality downwind of the dams to assess possible transportation of pollutants and particulates towards other communities.

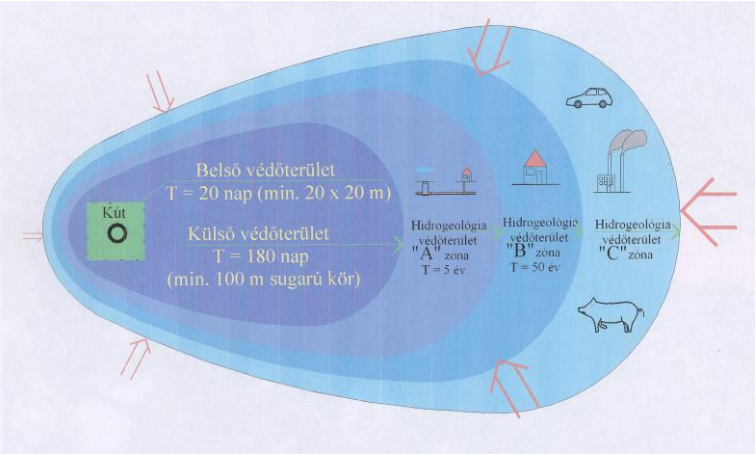
- Obtain reliable weather information (esp prevailing wind direction) to help predict the likely dispersion of contaminated dusts

Drinking water safety and sanitation

- The team visited the Bakonykarszt Viz és Csatornamű plc. water supply and sewage company. The company supplies water and sanitation services to 220,000 people for a daily average flow of 25, groundwater 000 – 30,000 m3/day. The company uses a mixture of resource waters: 82% of this is of karstic origin, 7% is groundwater and 12% is confined deep aquifer. Treatment consists of oxidation for the removal of Fe and Mn, filtration and disinfection by means of sodium hypochlorite. Treatment is done on location of the capture area.

- Hungarian law requires a tiered protection zoning scheme around water extraction points, based on the hydrogeological characteristics. For zone A the

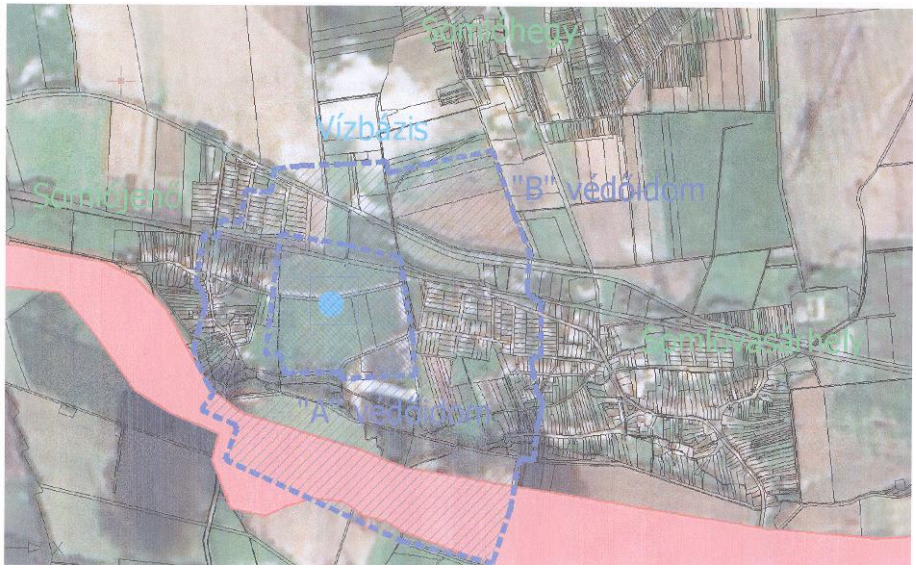
hydrogeological flow is 5 years, for zone B 50 years and, for zone “C” comprises the entire drainage area. Human habitation is permitted in zone B, industry in zone C.



Protection zone system (Source: Bakonykarszt Viz és Csatornamű plc. water supply and sewage company)

- There are two water extraction points in the affected zone: one in Devecser, consisting of two deep wells where the red mud did not reach zone B and one in Somlóvásárhely where the red mud did reach zone B. In both cases, the protection zones had been established based on tritium tests done in 2006 . The test showed perfect protection in Somlóvásárhely, but less than the standard requirements for protection in Devecser. This deviation from the standard is however of no significance from a health point of view

Water abstraction Devecser with “B” zone protection (Source: Bakonykarszt Viz és Csatornamű plc. water supply and sewage company)



Water abstraction point in Somlóvásárhely showing the penetration of the red mud in the "B" protection zone (Source: Bakonykarszt Viz és Csatornamű plc. water supply and sewage company)

- All houses in the service area of the company are connected by means of piped access in the home; wells and personal boreholes are not used for the provision of drinking water to residents in the affected region. Therefore, there are no groundwater abstraction points downstream of the accident.

- Nevertheless, there are private wells in the area, used in principle for watering the gardens etc. It can however not be excluded that some residents prefer using such wells over the comparatively more expensive piped water. Local residents should be advised to have the water tested before using it for personal consumption.

- The water company has contracted for hydrogeographic profiles of the water points, and updates these regularly (twice yearly check)

- The company has limited analytical chemical measurement capacity, but does pH, conductivity, nitrate nitrite ammonia, iron, manganese, sulphate, oxidability, chloride, hardness, calcium, magnesium, temperature and free chlorine. Heavy metals are measured by the Regional Institute of the National Public Health and Medical Officer Service.

- The water company proposed to develop monitoring boreholes between the contaminated sites and the water abstraction points on the border of the protection zone B in Devecser to allow surveillance of any heavy metal movement in groundwater.

- The team compared the most recent data with the WHO Guidelines for drinking-water quality for Cd, Ni, Mo, Cr, Cu, Zn, Hg, Pb, Al, Co in Kolontar and **found them to be below the WHO Guidelines for Drinking Water Quality**. Data regarding arsenic were not available on site at the water company, but have been shared with the team in Budapest**. The team is satisfied that drinking water supply and quality are adequate and pose no health risk.**

- The team noted that the National Public Health and Medical Officer Service, namely the National Institute of Environment and Health, which has an institutional role in the response to these events, lacks up-to-date analytical capacity and equipment that would be necessary to handle urgent information needs under emergency situation, and to pursue research to support risk assessment and characterization.

RECOMMENDATION 4 - PRESERVE AND CONTROL THE QUALITY OF DRINKING WATER

- Strengthen the contacts between water supplier and industry, particularly the setting up of direct communications in case of industrial accidents that may threaten either the water supply or the distribution network, shortcutting the more formal procedures used in times when there are no emergencies.

- Strengthen the capacity of the water laboratory of the water supplier for heavy metal analysis

- Model groundwater flow for heavy metals as a part of comprehensive risk assessment. We urgently recommend to verify whether the recharge zones of the wells was affected by the sludge. If the recharge zones can be proven to be unaffected, there is probably little risk. Existing experimental boreholes can be equipped with sensors indicating changes in pH and/or electrical conductivity; some models can send their findings by SMS to a central office.

River water monitoring

Marcal bridge

- On six points along the river big stones have been placed to slow the flow of the river, allowing settling. Gypsum (Calcium Sulfate) has also been added to the river to increase its buffering capacity.. The most affected areas are between km 60 – 70 from the mouth of the river. The sludge will be left until it can be removed.

    - Sampling is undertaken by BALIK environmental lab on behalf of the Central Directorate for Water and the Environment. The team concluded that sampling intensity collection at Marcal Bridge can be reduced

Kamond bridge

- At the Kamond bridge the river was still red and flocs could be observed in the water . River banks were stained deep red to several cm deep (walls of the river cracking). The red sludge wave going through the river caused a backup wave which had caused inundation of meadows in which cattle usually graze. The areas were cornered off and warnings were placed prominently warning of the hazard to trespassers. Villagers quickly surrounded the team asking when cattle

could be re-released: Environmental inspection followed by the taking down of the warning signs should not be forgotten.

Food safety

- The fruit and vegetables produced this year in the affected area have been damaged and will not enter the food market.
- Removal of sludge from agricultural soil is taking place. However, a further health risk characterizations is necessary, with input from additional experts, such as from the National Food Security Agency, to monitor the quality of soil and of locally produced fruit and vegetables, and animal food.

RECOMMENDATION 5 - MONITOR SOIL QUALITY AND CHECK SAFETY OFLOCALLY PRODUCED FOOD

Red sludge composition

- Contamination by arsenic and other metals have been reported in the media. However, the team could not examine any conclusive evidence. Further investigations are recommended based upon representative sampling to allow a better characterization of the type and quantities of heavy metals contained in the mud, to assess the existence of risks of possible exposures to hazardous and biologically persistent chemicals through water, food and air pollution.

- An analysis of 20 samples of sludge collected in Kolontár and Devecser and near the dam show that the metal content of the sludge is variable. The concentrations have been compared to the national permitted limits for sewage sludge used for soil improvement. In the case of arsenic and nickel, some samples were found to be below these limits and others were up to twice the limit. In the case of cadmium, chromium, mercury and lead, all samples were below the limit (Annex 5)

RECOMMENDATION 6 - COMPLETE THE CHEMICAL CHARACTERIZATION OF REPRESENTATIVE SAMPLES OF SLUDGE

- Analyze a representative set of samples of sludge taken from the reservoir, as well as from the contaminated area. The team understands that these analyses have been entrusted to the Hungarian Academy of Sciences.

- If the existence of protection measures including perimetric isolation in the subsoil with bentonite walls from the ground level till the first impermeable layer underground (clay stratus) at an average dept of about 20m is confirmed, a “hidden” reservoir may have been created where heavy metals filtering downwards from the reservoir 10 may have accumulated. Sampling should therefore not be limited to the remaining mud in the reservoir but should include the sub-surface “hidden” reservoir.

4. Other considerations emerging from the mission

- During the visit to the water company, the team informally learnt that under the reservoirs of the aluminum plant there are clay layers (water-tight) and that the walls of the reservoirs extend 20 m deep. Watertight walls (bentonite) extend under the bottom of the wall of the reservoir to the clay layer, forming an environment whence water cannot escape once entered for example from the bottom of the reservoir. It cannot be excluded that accumulation of water in this manner under the reservoir created instability in the retaining walls and caused the collapse.

- Equally urgent attention needs to be given to the geohydrological stability of the reservoir currently being used to receive the red mud and soil being scraped off the streets, houses and backyards.

RECOMMENDATION 7 - CLARIFY REMAINING UNCERTAINTIES REGARDING THE SLUDGE RESERVOIRS

- There is an urgent need to study the composition of the sludge remaining in the reservoir and especially to study the geo-hydrological stratification under the reservoir(s) to assess future risks. Urgent measures could consist in pumping off supernatant water to reduce pressure and allow a further drying of the underlying red mud.

- The reservoir used for the receipt of returned red mud and contaminated soil should be tested, and the safe freeboard assessed so that filling the reservoir would not lead to excessive pressure on the walls.

- Production process should be altered to include dewatering of red mud. Classic dewatering would yield solids with 20 – 30% water, BAT would allow to reduce this further to 10 – 15% water. The resulting dry solids need to be stored more safely.

- Mechanical characteristics of the ground under the reservoir should be improved so that incoming water and other liquid does not create mechanical imbalance

5. Trans-boundary effects

- The team has especially noted the great concern and efforts of Hungarian authorities to prevent further spread of the spill to the river Danube, which could lead to trans-boundary environmental damage.

- While available information indicates that the quality of the Danube river water has remained substantially unaffected, the event raises an important question regarding the need to develop a comprehensive environmental health risk mapping of similar installations, particularly in consideration of the existence of an estimated additional 150 similar waste reservoirs located along the Danube.

RECOMMENDATION 8 - ADDRESS ASPECTS OF TRANSBOUNDARY RELEVANCE

- It is recommended that a (re)assessment of the resilience of such industries and waste reservoirs to extreme weather events, such as heavy rains, floods, landslides, as well as of any risk of contamination of soil and ground water should be undertaken. This calls for the setting up of a risk assessment exercise of transboundary nature, which could take place under the umbrella of existing international agreements, such as the Protocol on Water and Health, to which Hungary is a Party.

Communication aspects

- The mission has uncovered a need for better and more evidence-based communication to the public, particularly on aspects of health concern related to exposures of workers and volunteers employed in cleaning up operations and of the returning and resident population. In particular, the mission has noted that public health experts from health institutions and the National Environmental Health Institute could be an important resource to provide technically correct and evidence based information to the public, and their support to communication activities through the media could be taken advantage of.-

- A greater involvement of the public health experts in ensuring that the public receives technically correct and evidence-based information on health related aspects could be of particular help to address concerns especially because the public has trust in them.

- A better understanding of the risk perception in the public would be instrumental to design appropriate health messages which address the concern public concerns.
- Central coordination of information delivery from different sectors and at from relevant levels is fundamental to ensure consistency of messages and avoid confusion.

RECOMMENDATION 9 -ENSURE THAT COMMUNICATION TO THE PUBLIC REMAINS TIMELY AND ACCURATE, USING AVAILABLE EXPERTISE FROM HEALTH INSTITUTIONS AND THE NATIONAL ENVIRONMENT AND HEALTH INSTITUTE, AS NEEDED.

Coordination aspects

- The mission's preliminary findings indicate the need for stronger coordination between monitoring and data collection activities performed by different bodies. If

a strong and comprehensive health impact assessment is to be performed, better integration of the different monitoring systems, and some *ad-hoc* analysis to assess potential risks (e.g alkalinity of dust) will need to be assessed. This appears of particular importance in view of the need to take stock of the lessons learnt through this event to improve emergency planning and preparedness.

- For example, the team learned that according to the Hungarian regulations, the water company is to receive alerts from local government. Acting with commendable promptitude and helped by the fortuitous fact that one of their service cares was in the area, the water company was on location twenty minutes after the accident. Rapid intervention proved essential since the sludge flow had already damaged the main service lines.

RECOMMENDATION 10 - STRENGTHEN COORDINATION OF EMERGENCY PLANS AND PREPAREDNESS

- Emergency planning and preparedness mechanisms need to be revised, taking into account the need for multi-agency involvement. It is recommended that a debrief occurs following the incident such that lessons learnt are factored into future planning and preparedness. Concomitantly, multi-agency training should be undertaken, including the development of scenarios and exercises. This will strengthen future resilience. Community engagement will also need to be a component to ensure that the public are engaged and understand the risks.

- An alarm system should be installed such that the water company receives timely alerting and notification of future incidents.

ANNEX 1

Institutions, experts and organizations met, field visits

12 October

Briefing with HCO WHO Country Office

13 October-

Meeting with the State Minister of Ministry of National Resources and the Chief Medical Officer

Meeting with the Director and expert team of the National Institute of Environment and Health

Meeting with IHR NFP, the Head of Rapid Response Department of the National Public Health and Medical Officer Service, member of operational team of Governmental Coordination Committee (GCC)

Meeting with the Deputy Director of Institute of Occupational Health

Meeting and briefing with the Secretary General of the Hungarian Academy of Sciences, Chairman of the Scientific group of GCC

Visit of local command of Devecser

Visit on site in Devecser with expert of NIEH focusing on air quality monitoring

Meeting with EU expert team

14 October

Meeting with the executive management of Bakonykarszt Viz és Csatornamű plc. water supply and sewage company.

Visit on site at Marcal river

Visit on site in Kolontar

Meeting with Regional Chief Medical Officer and team in Devecser, follow up necessary public health measures, meeting with local GPs, occupational health specialist, ambulatory care, health and safety officials

Meeting with experts at broken dam

Meeting with EU expert team

15 October

Meeting with the Minister of the Ministry of National Resources to discuss the findings of WHO expert team

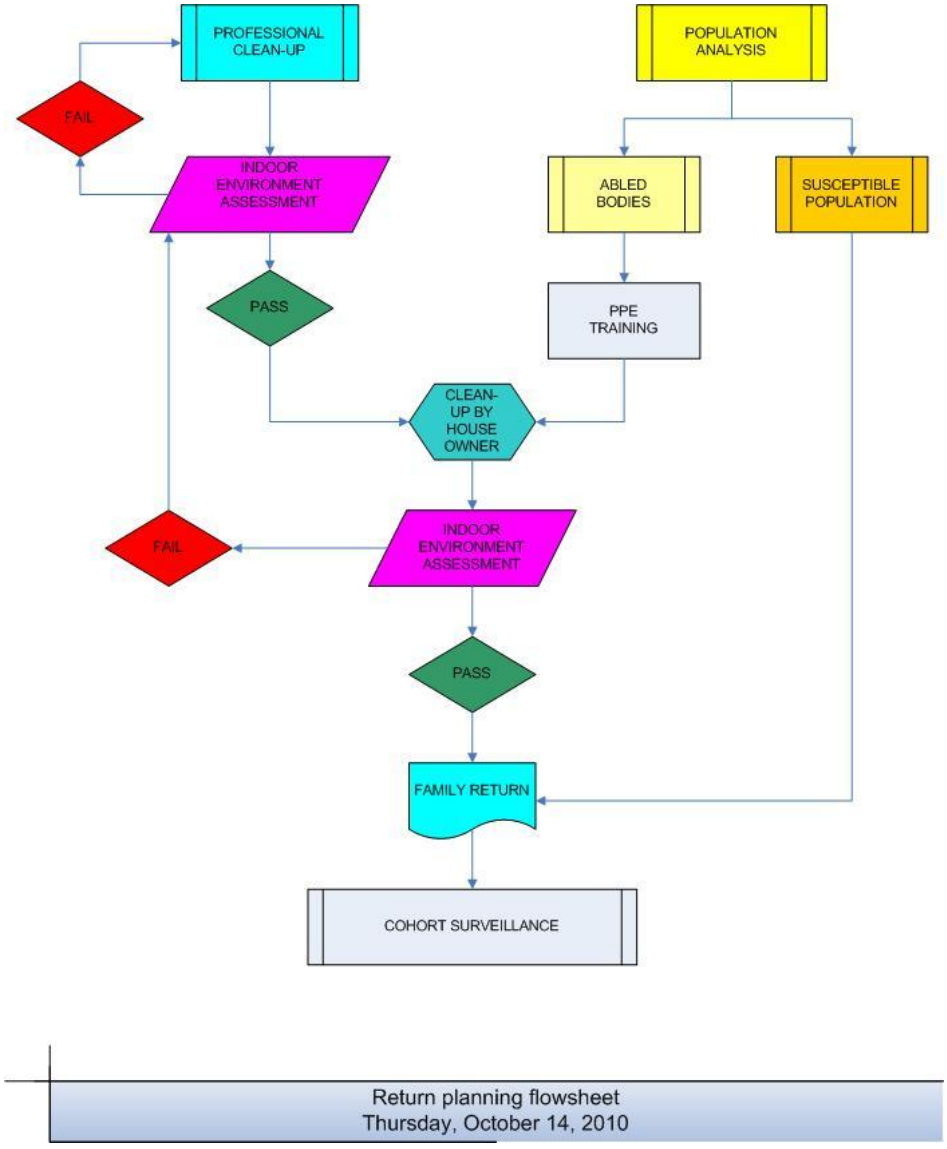
Meeting with national experts of National Public Health and Medical Officer Service and National Institute of Environment and Health to share information about the experience of the team

Meeting with the Director and Deputy Director of the National General Directorate for Disaster Management and representatives of GCC to report findings of the mission jointly by EC expert team

Annex 2. Number of residents in centres in the accident area

age gr	Apácatorna		Devecser		Kisberzseny		Kolontár		Somlójenő		Somlóvásárhely		Tüskevár		Total	
	male	*female*	*male*	*female*	*male*	*female*	*male*	*female*	*male*	*female*	*male*	*female*	*male*	*female*	*male*	*female*
0-4	7	6	117	111	3	6	16	25	8	6	35	26	14	10	200	190
5-9	6	3	144	128	2	0	27	18	8	9	30	39	15	15	232	212
10-14	7	7	175	163	6	1	23	18	13	16	42	38	11	21	277	264
15-19	3	10	157	168	5	3	36	31	13	16	46	41	18	20	278	289
20-24	3	2	176	174	3	1	25	38	8	9	39	48	23	12	277	284
25-29	5	6	182	173	3	1	35	40	9	7	54	35	19	23	307	285
30-34	12	8	220	196	0	4	33	39	16	12	59	41	26	22	366	322
35-39	12	7	185	172	6	5	28	20	10	10	52	35	26	16	319	265
40-44	5	4	201	170	3	2	23	29	18	11	34	34	30	21	314	271
45-49	5	2	182	164	5	1	37	28	15	12	49	51	15	13	308	271
50-54	7	7	185	184	2	3	38	34	11	4	49	29	22	21	314	282
55-59	10	6	183	152	3	5	22	18	5	6	29	45	25	24	277	256
60-64	5	8	131	151	4	5	16	19	6	9	33	25	22	20	217	237
65-69	6	8	107	140	3	2	9	15	11	10	19	20	8	23	163	218
70-74	7	5	80	121	1	3	17	24	6	8	13	25	6	15	130	201
75-79	4	4	55	111	1	6	9	12	5	7	7	28	5	3	86	171
80-84	1	2	39	75	1	2	7	12	3	4	5	12	3	13	59	120
85-89	0	0	14	43	1	5	2	4	0	3	5	11	2	3	24	69
90-94	1	0	0	11	0	1	1	0	0	0	0	4	1	2	3	18
95-100	0	1	1	0	0	0	0	0	0	0	0	1	2	0	3	2
Total	**106**	**96**	**2534**	**2607**	**52**	**56**	**404**	**424**	**165**	**159**	**600**	**588**	**293**	**297**	**4154**	**4227**

ANNEX 3:FLOW CHART FOR THE RETURN OF THE POPULATION



ANNEX 4

ADVICE TO HOUSEHOLDS TO REDUCE EXPOSURES

1) Family members employed for clean-up activities should take off their clothes dusted and clean themselves before entering the home.

2) It is recommended for all household members to leave street shoes outside and use a separate pair of clean home shoes inside only.

3) Wear masks and protective gear while performing cleaning up activities and always pay special attention to hand hygiene and frequent hand washing.

4) Use of chemicals for clean-up may be hazardous. It is advised to clean up with water rather than chemicals.

5) Before accessing cellars, please make sure that these have been cleaned up by professionals;

6) Small children and people with health conditions need to pay special attention. In particular, as children will be exposed by hand-to-mouth activities and by crawling on the floor, efforts should be made to reduce their possible exposures.

7) All food stuff should be disposed off and contaminated clothing washed

8) If possible, family life and sleeping should take place in upper floor levels as precautionary principle.

9) Keep the doors to rooms where drying fabric and clothing closed, to prevent the re-deposition of dust on cleaned clothes. .

ANNEX 5 - Main elements of the red sludge

Analysis carried out by the Hungarian institutions, 5-6 October 2010

Scientists of the Hungarian Academy of Sciences (HAS), Geological Institute of Hungary (GIH) and an independent organization, Bálint Analitika Kft, have analyzed 20 red sludge samples gathered in the area of Kolontár and Devecser. Further analysis is in progress. The data showed that the red sludge is a heterogeneous material and its content varies in different locations.
There are no regulations for the content of the red sludge so the data of the samples were compared to the limitations of the scourage mud used in agriculture for soil improvement (EU list code no: 20 03 06 = waste from sewage cleaning)

Samples	**Metal content of the red sludge (mg/kg)**						
	As	**Cd**	**Cr**	**Hg**	**Ni**	**Pb**	**Zn**
CRC HAS 05.10.2010.[1a]	135-144	n.d.	632-677	1,64-8,59	192-219	189-195	47,9 56,7
CRC HAS 05.10.2010.[1b]	33,4-35,7	n.d.	83,4-85,8	n.d.	64,3-73,1	43,2-53,9	36,8-43,6
Bálint Analitika 05.10.2010.[2]	43,6-44,5	2,30-2,42	689-721	0,54-0,67	281-289	80,9-83,2	142-155
Bálint Analitika 05.10.2010.[3]	27,9-32,3	0,24-0,34	57,6-74,5	0,18-0,28	26,3-36,4	7,52-11,8	64,2-77,9
GIH 06.10.2010.[4]	81,6-131	0,82-1,44	360-694	0,61-2,83	143-322	96,2-177	108-172
Limit values for scourage mud [6]	75	10	1000	10	200	750	2500

n.d. cannot be measured
[1a,b] data of the samples taken from 100 metres of the ruptured dam and from 1 kilometre West from Kolontár. The samples were collected by the Institute of Materials and Environmental Chemistry of the Hungarian Academy of Sciences on 05.10.2010;
[2] data of the 2 samples taken from 30 and 50 metres of the ruptured dam. The sample was collected by Bálint Analitika on 05.10.2010 (with limit values);
[3] data of the 2 samples taken within the municipality boundaries of Kolontár. The samples were collected by Bálint Analitika on 05.10.2010 (with limit values);
[4] data of the 10 samples taken from the area of Kolontár and Devecser. The samples were collected by GIH on 06.10.2010. (with limit values)
[5] Limit values of the scourage mud used in agriculture according to the 50/2001 (IV. 3) Governmental Decree.

Samples	**Metal content of the liquors (µg/l)**						
	As	**Cd**	**Cr**	**Hg**	**Ni**	**Pb**	**Zn**
CRC HAS 05.10.2010.[1] distilled water	k.h.a	k.h.a	k.h.a	k.h.a	190	60	k.h.a
CRC HAS 05.10.2010.[1] Ammonium Acetate, puffer	k.h.a	k.h.a	k.h.a	k.h.a	k.h.a	k.h.a	k.h.a
Demonstration limit of the measurement	***20***	***3***	***1***	***4***	***0,7***	***8***	***0,8***
Threshold limit for scourage mud [12]	***200***	***20***	***2500***	***10***	***1000***	***1000***	***5000***

k.h.a. – ***Under demonstration limit of the measurement***

[1] data of the two samples taken nearby of the ruptured dam and the outskirts of Kolontar. The samples were collected by the colleagues of the Institute of Materials and Environmental Chemistry of the Hungarian Academy of Sciences on 05.10.2010;

The very significant costs associated with removal, transportation and re-deposition need to be minimised by reducing the depth of the excavation to the level justified by analysis and interpretation of recorded contaminant levels. The savings in “dig and dump” costs would pay for the costs of getting this right. Several different coring methods could be envisaged and detail operational procedures can be provided if so desired by the Hungarian authorities. GPS loggins of the samples would provide spatial data essential for planning and design. Variations in depth of cover of red mud might indicate general topographical variations, or even local unevenness in the soil surface. An appropriate coverage rate (i.e. sample locations per hectare) would need to be established in order to determine appropriate depths of soil stripping at any point.

More in-depth analysis with further speciation of the heavy metals would allow a more exhaustive risk assessment. As an example, it should be necessary to investigate about the fraction of Cr^{6+} (a known carcinogenic) in the total chrome content.