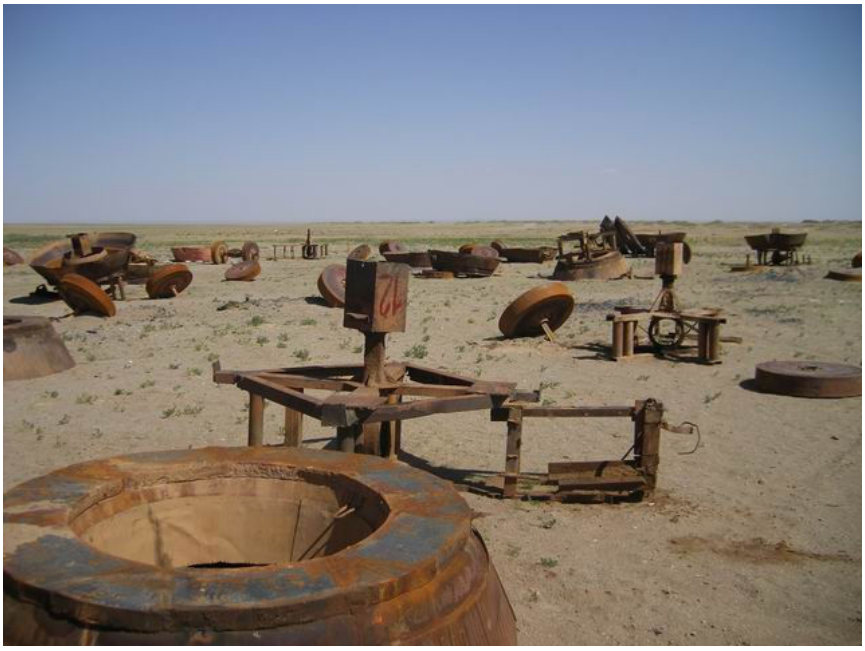
Fact-finding mission

Sodium cyanide and mercury pollution and mining related environmental emergencies in Mongolia



Joint UNEP/OCHA Environment Unit

July 2007

UNITED NATIONS

OCHA

Office for the
Coordination of
Humanitarian Affairs

UNEP

United Nations
Environment Programme

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Published in Switzerland, 2007 by the Joint UNEP/OCHA Environment Unit

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Cover photo: Alain Pasche. *Dismantled mill - Dorvoljin Teeg-Gobi, Mongolia*

Introduction

On 23 April 2007, an informal operation to process gold ore using mercury and sodium cyanide, polluted the ground, air and drinking water and caused intoxication amongst the population and loss of livestock in the soum of Khongor (Darkhan-Uul Aimag) approximately 200 km North of Ulaanbaatar. The Mongolian Government did not request international assistance to respond to this environmental emergency.

Later in June following a meeting between His Excellency Mr. S. Otgonbayar, Minister of Emergencies, Ambassador D. Boldbaatar, Mr. Y. Badrakh from the National Emergency Management Agency (NEMA) and senior representatives from the United Nations Office for Coordination of Humanitarian Affairs (OCHA), it was agreed to deploy an environmental expert through the Joint UNEP/OCHA Environment Unit (Joint Environment Unit). The objective of this mission was to undertake a fact-finding mission on the accident and the national response to it, and examine related environmental emergency risks stemming from the mining sector.

The Joint Environment Unit is the United Nations mechanism to mobilize and coordinate the international response to environmental emergencies. It also assists countries with response preparedness activities.

Since 1997, informal private mining activities have seen a sharp increase in Mongolia. It is currently estimated that there are up to 100,000 artisanal miners in the country. This number continues to grow in the context of the national transition to market economy and of unemployment rise.

While the use of mercury, sodium cyanide and other extremely poisonous substances is restricted in Mongolia, they have broadly been used in illegal processing gold ore in recent years. For this purpose, gold ore is crushed with mercury first and in result of amalgamation about 30 percent of the gold ore is extracted. The remaining 70 percent of gold ore is taken out from the waste by a solution of cyanide.

Those operations and the related use of highly toxic substances are carried out without any regards or considerations for safety. Therefore they pose a serious threat to human and animal populations, the wildlife and the environment.

The fact-finding mission took place between 23 June and 4 July 2007.

1. Goal and objectives of the mission

The purpose of this fact-finding mission was to obtain available information on the cause and impact of the spillage and to assess the actual and potential risks of this accident for human health and for the environment. The mission also investigated the risk inherent in the related mining activities.

The specific objectives were the following:

- Gather and review available information
- Assess current national capacity to respond to identified issues
- Provide technical advice on actions to alleviate actual/potential impacts
- Provide recommendations to prevent possible re-occurrence of similar incidents and recommendations on response and response preparedness actions.
- In consultation with the Office of the UN Resident Coordinator and relevant national authorities recommend ways to integrate environmental emergencies into contingency and response strategies

Mercury used in gold mining can end up in the food chain and cause long-term environmental and human health impacts

2. Mission Agenda

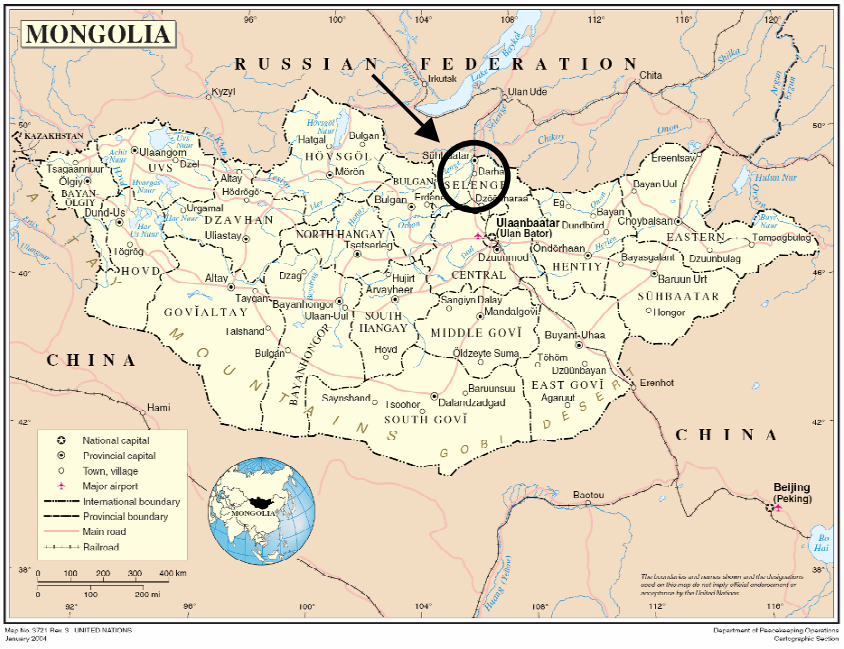
Date	Event	Location	Participants
23 June	Arrival in Ulaanbaatar		
24 June	*Day off*		
25 June	Briefing with UN RC a.i. and UN Country Team	UNDP Country Office	Ms. Delia Barcelona, Mr. Hagan, Mr. Bertrand Desmoulin, Ms Shoko Noda, Mr. Joscha Stillner
	Briefing with NEMA	NEMA Headquarter	Mr. P.Dash, Mr. T.Ganbold, Mr.Ch.Batchuluun, Mrs.D. Bazarragchaa i, Mr. G. Buyantogtokh
	Meeting with Ministry of Industry and Trade	Government Building-2	Mrs. Ch. Chuluuntsetseg, Mr. A. Khurelbat, Mr. D. Amarjargal
	Briefing with Ministry of Environment	Government Building-3	Mr. Ts.Shiirevdamba, Mrs. L. Jargalsaikhan
	Meeting with the Expert Group	Government Building-3	Mrs. L..Jargalsaikhan, representatives from MoIT, State Special Inspection Agency, MoFA, MoH, Academy of Science, Mongolian National University
	Meeting with UNFPA (informal mining and migration National Project)	UNDP Country Office	Mrs. Delia Barcelona, Mrs. A.Bazar
26 June	Field assessment - Visit to the sodium cyanide pollution site	Drakhan Uul (200 km from Ulaanbaatar)	Mrs. L.Jargalsaikhan, Mr. G. Buyantogtokh
27 June to 30 June	Field assessment – visit of various informal gold ore processing installations and of the Baigal Alt (Nature Gold) Project (tailings treatment installation)	Various locations in the Khanbogd Soum (Gobi desert-750 km from Ulaanbaatar)	Mrs. L. Jargalsaikhan, Mr. G. Buyantogtokh
1 July	Drafting report	Bayangol Hotel	
2 July	Visit of the NEMA NBC Special Rescue Unit	NEMA Special Rescue Units Headquarter	Mrs. L.Jargalsaikhan, Mr. G. Buyantogtokh
3 July	Debriefing with UN RC/UNDP RR	UNDP Country Office	Ms. Pratibha Mehta, Mr. Joscha Stillner

3. Mission Findings

3.1 The sodium cyanide and mercury pollution

➢ The accident

The accident occurred at an informal mining installation at the premises of an abandoned factory located in the village of Khongor Soum, approximately 200 km north of the capital Ulaanbaatar. The processing of gold ore using mercury started in 2006 and accumulated a great quantity of waste containing mercury. The processing of this waste by sodium cyanide to extract remaining gold began in February 2007. The related wastewater containing cyanide and mercury was subsequently poured directly to the waste treatment plant. That plant, located in the outskirts of the village, flowed over and created a pond with an estimated surface of approximately 560 m^2. As a result, the drinking water well and water supplying system were polluted. In addition, the ground of the village was contaminated by mercury since the waste was not covered and spread by the wind.



On 23 April 2007, 3 cows and a sheep were found death. It is assumed that they died from drinking from the pool. Mercury was found in their stomach by veterinary autopsy.

Authorities took samples of soil, tailings, water of the pond of waste water treatment, the drinking water well and water of the supplying system and analysed them at the Central Geological laboratory, the Institute of Chemistry and Chemical technology, the laboratory of the State Special Professional Inspection Agency. Analysis showed that the samples contained high amounts of mercury and cyanide. The cyanide concentrations exceeded by 13 to 65 times the national standard for drinking water

(MNS 0900-1992) and 2.6 to 3700 times higher than the national standards for wastewater (MNS4943-2000).

➢ Decontamination plan

Based on the analysis, a decontamination plan was developed by the National consul of toxic and hazardous chemicals and implemented:

Solution of polysulfide (DTOX - 39% weight/weight of Sodium polysulfide -NaS_x) was used for the decontamination of the polluted wastewater, tailings and sludge. The toxic cyanides were transformed into non-toxic compounds according to the following chemical reaction:

$$NaCN+2NaS_x+2O_2+2H_2O = Na_2CO_3+NaNO_3+2H_2S_x$$

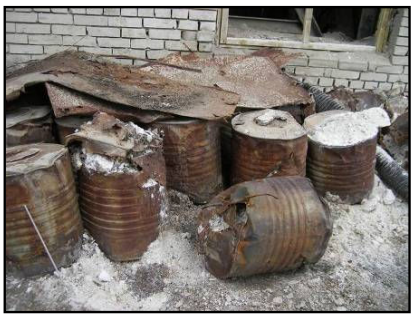
The toxic mercuric ions (Hg^{2+}), which tend to bio-accumulate[1], were precipitated as mercury sulphide (HgS). Under this stable form, mercury is not evaporable and therefore does not represent any threat to the environment, the livestock or the population.

$$Hg+NaS_x \rightarrow HgS$$

Tailings and solid waste

Approximately 1,192 tons of tailings and solid waste resulting from the illegal gold ore processing was collected and transported to the Boroo Gold mine to be safely treated.

The contaminated tailings were spread out on an impermeable ground and levelled to form a layer of few decimetres. The DTOX solution was then sprayed all over the surface of this layer by a special decontamination vehicle that belongs to the NEMA Special Rescue Unit. After the completion of the decontamination operations, the tailings and the solid waste were disposed of, along with the Boroo Gold mine residues.



Poor environmental practices were common in the informal gold mining sector

Cyanide solution

The sodium metabisulphide was used for the decontamination of the 18.5 tons of sodium cyanide solution. Qualitative tests were conducted repeatedly to insure that

[1] *Bioaccumulation* is a general term for the accumulation of substances, such as pesticides, methylmercury, or other organic chemicals in an organism or part of an organism. The accumulation process involves the biological sequestering of substances that enter the organism through respiration, food intake, epidermal (skin) contact with the substance, and/or other means. The sequestering results in the organism having a higher concentration of the substance than the concentration in the organism's surrounding environment. (http://toxics.usgs.gov/definitions/bioaccumulation.html)

no cyanides remained in the decontaminated solution before discharge in the environment.

Pond and effluents

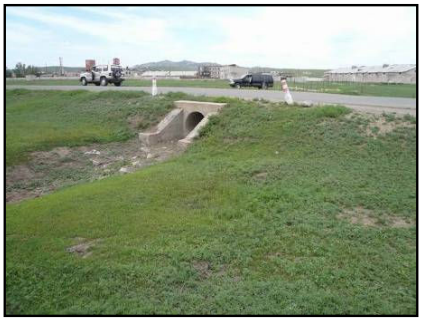
The pond (surface 560 m^2) formed by the contaminated overflow coming from the wastewater treatment plant was located outside the premises used for the gold ore processing. The pond was also decontaminated by adding DTOX solution. Tests were conducted to ensure that, after decontamination, the water and the sludge were free of cyanides.

The liquid was left in place to evaporate.

Wastewater treatment plant

Prior to discharge into the environment, wastewater passes through two small installations composed of sedimentation basins only. No biological or chemical treatments were observed. In absence of data concerning the characteristics of the raw effluent, flow and settling time, it was not possible to assess the efficiency of the treatment plants.

Both installations were found contaminated by cyanides. The pipe that brings the effluent to the installation as well as the sedimentation basins were treated with sodium polysulfide until the wastewater was free of cyanides.



The mining spill is considered Mongolia's first major environmental emergency

➢ Impact

The Mongolian authorities consider this accident the first major chemical emergency in the country.

The major impacts of the pollution are summarized below:

- A surface area 44,790 m^2 of soil contaminated with mercury and sodium cyanide.
- Ground water and drinking water supplies contaminated
- Contaminated drinking water well and wastewater treatment plant
- 1192 tonnes of highly contaminated tailings (mercury and cyanide)
- 18.5 tonnes of sodium-cyanide solution
- Pond of wastewater 560m^2
- A canal of wastewater of 900m
- The death of 3 cows and a sheep.

As part of the response measures taken, 1,427 persons underwent medical examinations with the following results:

- 196 showed signs of minor intoxication (1 symptom),
- 30 showed signs of more serious intoxication (2 to 3 symptoms),
- 5 were hospitalised, while another 612 persons received medical treatment.

In addition, the soil of a classroom at the Khongor School was also found to be contaminated with mercury (probably resulting from the use of contaminated soil for repair or refurbishing). The soil has subsequently been removed.

Fortunately, no casualties resulted from this accident. The immediate consequences could have been more serious, considering the quantity of hazardous chemicals released.

3.2 Addressing informal mining sector

Immediately after the completion of the decontamination operations in the Khongor soum, the Mongolian authorities conducted an extensive, nation-wide inspection to uncover illegal mining activities. The Ministry of Industry and Trade, the Ministry of Environment, the Special Professional Inspection Agency, the Police and NEMA conducted this operation. As a result, 145 mercury-using mills were dismantled and 35.22 kg of mercury and 1,200 kg of sodium cyanide were confiscated.

4. Discussion of findings

Along with the exposure of informal miners to the toxic emanations resulting from gold extraction, some other issues should also be taken into consideration:

4.1 Abandoned tailings and associated environmental problems

Throughout the country, large tailings ponds can be found without any safety or containment measures. Rain and the wind will spread the tailings over large areas causing pollution of the soil and underground water and ultimately to an accumulation of mercury in the food chain.

In the two locations visited, the tailing ponds were adjacent to soil depressions, which turned into large pools of standing water during rainfall. These pools are used as watering points for animals. Pollutants contained in the tailings can easily contaminate the standing water and subsequently enter the food chain.

Abandoned tailings can increase pollution of soil and underground water

4.2 Emergency response staff works under dangerous conditions

The Ministry of Environment and NEMA experts have no adequate safety and personal protective equipment. During response situations, they are insufficiently protected when carrying out their duties, and are exposed to pollutants.

In the case of this specific sodium cyanide and mercury accident, the team of experts carried out the decontamination operations without any personal protective equipment such as protective suits, rubber boots and gloves, respiratory protection, and safety glasses.

4.3 Response decisions hampered by lack of real-time information

Since all laboratories are located in Ulaanbaatar, any samples taken have to be sent to the capital for analysis. Transportation of samples is therefore a logistical challenge and inefficient when fast and/or immediate results are required. In the case of this sodium cyanide and mercury accident, this delay had no noticeable consequences.

The consequences of the chemical pollution in Khongor could have nevertheless been completely different if other substances and concentrations were involved and larger populations directly exposed. In the event of a chemical accident, it is crucial to have the first analysis results available as soon as possible, including on-site measurements as critical operational decisions depend on them.

The lack of protective equipment and suitable measurement devices could have led to potentially harmful exposure of the team of experts involved in the assessment and in the decontamination operation.

4.4 Urgent need for improved capacity for chemical emergency responders

Despite their vast knowledge and expertise in the chemical field, the majority of the experts involved in the assessment and decontamination operations were not trained to respond to chemical emergencies, or to conduct field operations.

4.5 Future trends draw bleak picture

It is commonly accepted that under the rapid expansion of the industrial sector, the mining sector in particular, the transport and use of large quantity of chemicals will continue to expand in Mongolia. This will inevitably also increase the probability of chemical accidents with significant consequences to the population and the environment.

5 Recommendations

5.1 Urgently protect and reprocess tailings with improved technologies

In order to avoid the spread of pollutants in the environment from tailing ponds located throughout Mongolia, it is recommended to take necessary measures to protect all tailing ponds from the wind and precipitation. Covering them with heavy-duty plastic sheets that are appropriate for the local weather conditions can achieve this recommendation.

Secondly, the treatment or reprocessing of tailings should commence in an attempt to remove remaining gold ore, which would also provide another economic opportunity. This reprocessing should take place, however, in an environmentally satisfactory manner (excluding the use of mercury) and respect good labour practices.

5.2 Identify urgent needs for PPE and mobile chemical analysis

As a matter of priority, a needs-assessment should be carried out to identify the suitable personal protective equipment (PPE) and portable measurement devices, which should be acquired by NEMA to effectively and safely respond to a chemical emergency. The necessary laboratory equipment or devices and reagents for testing of mercury and cyanides should be acquired.

It is suggested to discuss these findings with UNDP, interested donor countries and financial institutions, which might be in a position to provide financial support.

The Joint Environment Unit can assist in the undertaking of this type of needs-assessment.

5.3 Connect to the international environmental emergency response community

In order to become fully acquainted with possible assistance offered by the international community for preparedness and response activities for environmental emergencies, including training and exchanging ideas and experiences, it is recommended that NEMA and the Ministry of Environment appoint a 'National Focal Point on Environmental Emergencies' to act as a link between Mongolian authorities and the international community of environmental emergency responders.

5.4 Response Preparedness and Capacity Building

Training on chemical emergency response and safety should be organized for the Mongolian group of experts that was responsible for the response and decontamination of the accident site. Methodological trainings for laboratory staff to test mercury and cyanides in environmental and biological samples should also be conducted. Furthermore, there is a general need to develop clinical protocols and guidelines for diagnosis and treatment of poisoning caused by acute and chronic exposure to cyanide and mercury and conduct training for health care workers.

In addition, environmental emergencies should become fully integrated into the Contingency Planning and other relevant response preparedness activities in Mongolia. It is advised to build a national capacity for health risk assessment of environmental exposure to toxic chemicals, including mercury and cyanides.

The Joint Environment Unit can assist in carrying out the training and is also able to organise response preparedness workshops on environmental emergencies.

5.5 Mercury testing

Currently, analyses of cyanides and mercury in biomaterials (blood, urine) and food products are not carried out in Mongolia. It is due to lack of laboratory capacity and lack of training and experience of laboratory staff:

- The Central Laboratory of the Public Health Institute is equipped with the atomic absorption spectrometer-VARIAN. Currently, it doesn't determine mercury due to the absence of some needed devices, reagents.
- The laboratory of the City Specialized Inspection Authority has a cold vapor atomic absorption spectrometer. Currently, the laboratory analyses lead, cadmium, cupper, zinc, iron, cobalt, nickel and silver in food, water and soil. However, testing of mercury is not carried out. For testing mercury in the environmental and biological samples, provision of argon gas, additional parts for AAS equipment such as gas-liquid separator spare, quartz cell (mercury flow through cell vendor) and reagents will be needed.

Training of laboratory staff on methodology and technique for testing of cyanide and mercury is essential. In addition, knowledge and skills of medical doctors on diagnosis and treatment of cyanide and mercury poisoning and provision of antidotes need to be improved.

Because of the improper gold amalgamation operations carried out by the artisanal miners and because of the large number of unprotected tailings ponds scattered throughout Mongolia, extensive mercury contamination of the environment and subsequent exposure of the population is likely to occur in the future (through direct contact or through bioaccumulation and bio concentration). In order to enable the Ministry of Health to carry out an efficient monitoring of the health impact of the mercury in Mongolia, it is recommended to take all necessary actions to acquire the requested capabilities and/or equipment to test mercury in urine and blood samples. It is also recommended that the Ministry of Environment will liase and exchange information on this issue with the Ministry of Health and World Health Organisation.

The health impact of informal mining practices requires attention

ANNEX: Chemical accident of Khongor Sum - Chronology of events

Date	Events
24 April 2007	4 animals found dead (livestock) near an abandoned industrial facility
25 April 2007	Soil and water samples taken by the local branch of the "Special Inspection Unit" and sent to Ulaanbaatar for analysis
2 May 2007	Experts from NEMA, MoE and Special Inspection Unit carried out the first joint site assessment
10 May 2007	First analysis results available: high concentration of mercury and cyanide found in water and soil samples
12 May 2007	Expert group meeting - situation assessment
13 May 2007	Expert group meeting – selection of the suitable decontamination methodology, preparation of a plan of actions
	Air samples taken in different places of the contaminated area
14 May 2007	Minister of Environment accept the plan of actions submitted the day before by the Expert group
15 May 2007	Air samples analysis results available: concentration of mercury exceeding the national standards ($3.3x10^{-3}$ [mg/m^3]) found in all samples
16 May 2007	Beginning of the decontamination operations
28 May 2007	Completion of the decontamination operations