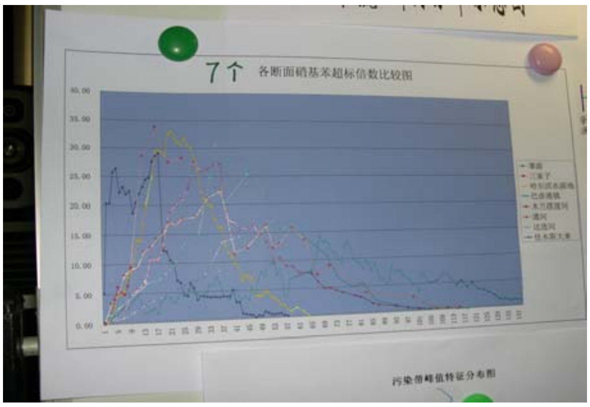
United Nations Environment Programme

The Songhua River Spill
China, December 2005

- Field Mission Report -



Acknowledgements

The UNEP mission team would like to express its sincere appreciation to China State Environmental Protection Administration (SEPA) and the Environmental Protection Bureaux of Heilongjiang Province, Jiamusi and Harbin, as well as SEPA Environmental Monitoring Centre, Heilongjiang Environmental Monitoring Centre and Jiamusi Environmental Monitoring Station. The efficient and friendly assistances and candid communication provided by their staff members enabled the mission team to conduct the field study within a very short period of time. Appreciation is also expressed to SEPA for the provision of maps and data used in the report.

UNEP would also like to thank the UN Country Disaster Management Team in Beijing for meeting with the mission team during the weekend and after working hours to provide advice, suggestions and receive debriefing. The same thanks go to our sister organization, the World Health Organization for providing background information on the pollutants and health impacts. The team also expresses appreciation to the Organization for Coordination of Humanitarian Assistance (OCHA) for its support with this mission.

The mission team acknowledges Reliefweb and UNOSAT for providing maps to be used during the mission for information and reference to the mission team and also to be used in the report.

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1 Introduction

Following an accident in a petro-chemical plant that led to a major pollution on the Songhua River in China, the Chinese State Environmental Protection Administration (SEPA) invited an expert team of the United Nations Environment Programme (UNEP) for a field mission to the affected region. This report reflects the findings of the team.

1.1 Background to the spill

The team was informed that on 13 November 2005, an explosion occurred at a petrochemical plant of the Jilin Petrochemical Corporation in Jilin Province, China. The information available indicated that the explosion led to a spill of an estimated 100 tons of toxic substances made up of a mixture of benzene, aniline and nitrobenzene, with surface waters concentrations exceeding the surface water levels permissible in China. The ratio of the substances spilled is not known at this time and investigations on the accident site are ongoing. The pollution entered subsequently the Songhua River and a plume of contamination started flowing downstream. The Songhua River joins the Heilongjiang River and forms a natural border with the Russian Federation. The River continues into the Russian Federation and is named the Amur River. The river flows into the Sea of Okhotsk.

1.2 Scope of the mission

Following the accident, on 5 December 2005 UNEP was invited to conduct a site visit to the pollution belt along the Songhua River with the following terms of reference provided by SEPA:

- Conduct an on-site visit to the major affected cities;
- Discuss with local officials about the recent incident and measures taken for protecting public health and the environment
- Discuss with national and local experts on the pollution situation and the measures taken so far.
- Provide possible advice to the government of China on the environmental disaster prevention in the future.

After the visit UNEP discussed with senior officials of SEPA the major findings and possible recommendations for further immediate actions for reducing and treating the pollution.

UNEP regrets that it was not in a position to share expert opinions on public health measures since the request to include a public health expert in the mission was not accepted by SEPA. Therefore, the public health aspect has been omitted from the original terms of reference.

1.3 Mission team

Upon receiving SEPA's invitation, UNEP immediately deployed a 4-member field team consisting of the Head of the Implementation Unit, Production and Consumption Branch, Division of Technology, Industry and Economics (Team Leader); the Country Coordinator of UNEP's China Office, the Regional Industry Officer of the Regional Office for Asia and the Pacific; and the Programme Officer of the Joint UNEP/OCHA Environment Unit. Mrs. Monique Barbut, Director, Division of Technology, Industry and Economy of UNEP joined the field team for final discussions with SEPA.

The mission took place between 9 and 16 December 2005. A detailed mission itinerary is provided in Annex 1.

1.4 Meteorological conditions

During the field mission, the temperatures in Jiamusi and Harbin ranged between -10 and -14 degrees Celsius during daytime, and between -21 and -23 degrees Celsius at night. No precipitation was observed during the mission

2 Observations and Discussions

This section describes the observations made during site visits and meetings with government officials and presents discussions on this. The section focuses in particular on the overall pollution situation, organizational response to the event, monitoring activities carried out by SEPA and Monitoring Centre's and specific pollution mitigation measures, and medium and long term measures planned by SEPA on impact assessment and damage mediation. SEPA is one of the actors in a greater system responding to the spill. The terms of reference did not invite the UNEP team to make any observations regarding the overall systematic response to the event. The descriptions below are provided based on the terms of reference, limited time frame of the mission, as well as information available to the mission team.

2.1 Description of the Songhua River Spill

An explosion occurred on 13 November 2005 at a petrochemical plan of Jilin Petrochemical Corporation, located in Jilin city of Jilin Province. The information provided indicated that the explosion resulted in spill of an estimated 100 tonnes of benzene, aniline and nitrobenzene into the Songhua River. The ratio of the substances spilled is not known at this time. SEPA coordinated monitoring showed only benzene, nitrobenzene and aniline in the No.2 Songhua River (in Jilin Province the river is called No. 2 Songhua River, in Heilongjiang Province it is named Songhua River) exceeding permissible level in surface water. Only the concentration level of nitrobenzene exceeded the permissible level in surface water in the downstream area starting from Harbin in Heilongjiang Province. Benzene, nitrobenzene and aniline are toxic chemicals. The China permissible level in surface water for these substances are: Benzene - 0.01mg/L and Aniline – 0.1 mg/L. For Nitrobenzene 0.017mg/L is the standard of the water source for drinking water. The Fact Sheets of benzene, nitrobenzene and aniline are presented in annex 2.

The concentration of benzene and nitrobenzene in the river immediately after the spill was unknown. The pollution plume reached Harbin city on 25 November 2005. The peak concentration of nitrobenzene on 25 Nov. was 0.581mg/l, 33.15 times the permissible level. On the same day, the concentration of benzene was below the permissible level and aniline was not detected.

Tracking the pollution plume at Jiamusi monitoring station

The pollution plume flowed downriver at a rate of 1-1.5 kilometres per hour. The front of the pollution plume reached Jiamusi city on 10 December 2005. The stretch of the plume was 80 km when passing through Harbin and it extended to 150 km long when it passed through Jiamusi.

In order to dilute the pollutants concentration, water flow from the Fengman hydroelectric power station into the river was increased. However, no information was available on how much more water was released. The city of Harbin's (population 4 million) water supply obtained from the Songhua River was shut down from 23-27 November 2005 as a safety measure. Dalianhe town of Yilan Country with a population of 20,000 also uses the river as a source of drinking water. SEPA informed that these were the only two places that used the Songhua River directly as a source for drinking water.

According to the monitoring results of SEPA on 11 December at Jiamusi cross section the concentration of nitrobenzene was 0.173 mg/l. The surface of the Songhua River is currently frozen, and some of the nitrobenzene is captured in the ice. The preliminary tests by the China Academy of Environmental Sciences indicate that the concentration of nitrobenzene in tested ice sample is one fourth of that in water.

As of 14 December, 2005, the head of the pollution plume had passed the monitoring point in Huachuan. Nitrobenzene concentrations at various monitoring stations along the Songhua River are indicated in Section 2.3 of this report.

2.2 Coordination of response

The mission team was informed that at the central government level, the State Council (consisting of all Ministers) established a task force for handling the Songhua River Water Pollution Incident. The task force coordinates a number of working groups. Information on the overall coordination and composition of the task force was not made available to the mission team. SEPA heads the working group on monitoring and prevention with the newly appointed environmental minister as the leader. This working group includes the Ministry of Water Resources, Ministry of Construction, Ministry of Agriculture, the China Academy of Sciences, Heilongjiang Provincial government and the Jilin Provincial government.

At the provincial level, a similar organizational structure has been set up to coordinate the response to the emergencies caused by the chemical spill. The responsibility of the Environmental Protection Bureaux, as the mission team was informed, is mainly monitoring the water quality, reporting to the relevant authorities to take actions, providing advice on responses by local authorities, as well as carrying out impact assessments and research for medium and long term actions.

2.3 Emergency pollution monitoring

During normal, non-emergency events, monitoring of water quality falls under the responsibility of SEPA. It receives technical guidance for this task by its subsidiary, the National Environmental Monitoring Centre (NEMC). SEPA requested the NEMC for the development of a specific monitoring regime during this emergency. The structure of SEPA and NEMC is replicated at provincial, autonomous region and municipality level by Environmental Protection Bureaux and Monitoring Centres. Similarly, emergency monitoring plans have been prepared at the local level.

On 18 November, 5 days after the accident, the State Environmental Protection Administration issued emergency monitoring instructions to its provincial counterpart, Heilongjiang Environmental Protection Bureau. The instructions provided by SEPA focussed on three important areas:

- the location and speed of the pollution plume;
- the concentrations of benzene and nitrobenzene in the river water; and
- the length of the pollutant plume.

These three factors enabled authorities at different levels to take timely and appropriate mitigation measures. Unfortunately, this effective effort of SEPA had not been communicated with the public sufficiently. Had this communication been adequately provided, the level of uncertainty and fear by public would have been lower.

After receiving the instruction, the provincial EPB immediately activated the emergency monitoring plan and started monitoring benzene and nitrobenzene concentration the same day at Zhaoyuan monitoring section, which is situated 163 km upstream from Harbin city (see also map on page 9).

<u>Photo: Chemist analysing water samples using Gas Chromatograph/Mass Spectrometer at the Jiamusi Environmental Monitoring Centre</u>

SEPA issued a special guideline for the monitoring of the two substances, specially for nitrobenzene since it is not included in the normal water quality monitoring procedure. In addition, SEPA deployed over 50 experts and 18 pieces equipments from all over the country to strengthen the monitoring capacity. The tests for benzene and nitrobenzene are conducted with gas chromatographic (GC), and/or gas chromatograph/mass spectrometry (GC/MS).

Samples are taken every two hours, and every hour during the time the plume passes through from three locations of each cross-section, one in the middle of the river and two on each side from the middle. At each location, samples are taken at 0.5m below the surface and at 0.5m above the riverbed. The samples taken from the same cross section of the river at each sampling time are mixed before been tested. The test results of the concentration are the mean concentration at a given time and at given a cross section of the river.

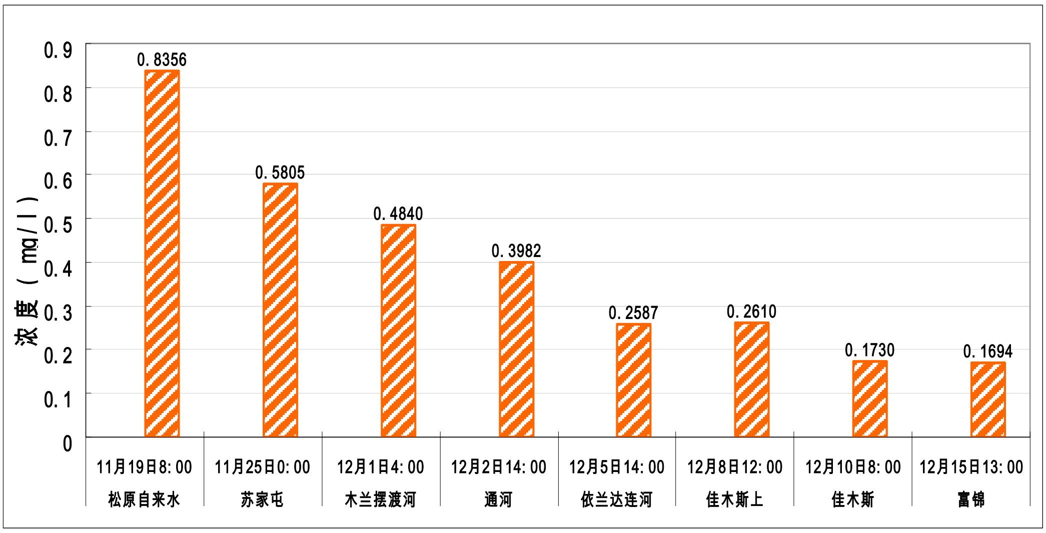
The sampling of the river water proved to be a challenging task especially right after the accidents. The regular monitoring of the water quality at Songhua river water is carried out monthly from April to October. During the winter months, the river quality is not monitored except for research proposes due to the difficulties in taking samples. In November when the river was in the process of icing, no proper means and methodologies were available for taking samples and the monitoring experts had to develop temporary means for sampling.

At present sampling in the Songhua River (as observed at Jiamusi) is carried out 0.5 metres below the ice layer and 0.5 metres above the river bottom. It is suggested that water sampling be also carried out at the river bottom since nitrobenzene is denser than water. This would necessitate the use of both horizontal sampler and vertical sampler (as being used at Jiamusi).

The mission team suggested that independent sampling and chemical analysis by an external laboratory be conducted. Consideration could be given for collaboration between international reference laboratories and Chinese environmental monitoring laboratories involved in this assessment.

The concentrations of benzene and nitrobenzene are monitored at 30 cross sections (see cover page) of the Songhua River from the site of accident to the border with the Russian Federation. The table below indicates the key monitoring points along the Songhua River and peak nitrobenzene levels monitored.

Peak Nitrobenzene concentrations measured in the Songhua River.



Songyuan	Sunjiatun	Mulan	Tonghe	Yilandalian	Pre-Jiamusi	Jiamusi	Fujin
8.00 19 Nov	0.00 25 Nov	4.00 1 Dec	14.00 2 Dec	14.00 5 Dec	12.00 8 Dec	12.00 8 Dec	13.00 15 Dec

Source: SEPA, December 2005

Map: Key sampling locations.

Source: SEPA, December 2005

The data shows the general reduction in pollution concentrations as the plume moves down river. The reducing concentrations are probably mainly due to the dilution factor and the elongation of the plume.

The Provincial Environmental Monitoring Centre is responsible for providing technical guidance to the monitoring stations at local levels, quality assurance and control of the monitoring carried out by the local environmental monitoring stations. Processing all the data and preparing overall reports. Monitoring date are reported by each monitoring station to the provincial EPB and provincial Monitoring centre to be verified, issued by provincial EPB and then shared with municipality government and the public.

Photo: Tracking the pollution plume (shaded part of river) at Heilongjiang Monitoring Centre in Harbin.

The Provincial Environmental Monitoring Centre of Heilongjiang has also analysed samples for the presence and concentrations of aniline, benzene family, and phenols. It also monitored Chemical Oxygen Demand (COD), Biological Oxygen Demand (BOD) and other regular monitoring parameters. However, besides a very moderate amount of aniline, no other substances were detected. Hence the monitoring of other substances than benzene and nitrobenzene were not requested of monitoring stations along the Songhua River. Samples of ice, sediments and fish are taken for monitoring and impact assessment purposes. However, most of the analysis would be carried out after the emergency responding work due to the current high demand for technical capacity on emergency monitoring.

The mission team noted that nitrobenzene (and possibly other chemicals that may have been released) is heavier than water and would sink to the bottom of the river. It will move downstream with the pollution plume but at a slower rate and may even fall behind and/or remain in some locations. It is therefore important to monitor bottom water (just above the sediment), the sediment itself, benthic organisms and bottom feeders to determine the levels and impacts. It has the potential to be damaging because it may be concentrated particularly in the higher reaches of the river closer to the accident site and because it is only sparingly soluble in water.

No air monitoring on nitrobenzene and benzene was carried out as response to the spill. Nitrobenzene has a higher density relative to air and its vapor may settle. This has a potential to impact on living organisms. It is suggested that air monitoring be undertaking in order to determine if appropriate response is required. Since much of the river is covered by ice this problem is limited during the winter but it has a potential to be of concern during the spring when the ice melts. The removal of nitrobenzene from the air through washout in rainwater or dry deposition should be investigated but may not be significant.

The provincial environmental monitoring centre gave special attention to the water quality monitoring at the intake point for drinking water supply for Harbin. However, the environmental monitoring is mandated only to monitor the natural water body quality, not the drinking water quality. The monitoring at the water treatment plant is carried out by the water company. The monitoring of drinking water quality is the responsibility of the health authority and is carried out by the disease prevention and monitoring station of the municipality. However, the mission team suggests to ensure that all drinking water supplies along the river including ground water and wells should be monitored for the substances released in the spill and appropriate actions taken to ensure the population is not exposed and put at risk. This should be done in cooperation with the World Health Organization.

2.4 Pollution control and mitigation measures

At the preliminary stage after the accident, China had adopted a series of mitigation measures including: 1) shut down all the waste discharging pipelines within the production facility area; 2) use of sand bags and construction wire to block fire fighting water and production wastewater from entering into the drainage pipelines; 3) diverting some wastewater into the wastewater treatment plant; 4) use of special vehicles to collect the remaining wastewater at the site of the accident.

In addition to the above provided measures, water was released from the Fengman hydroelectric power station water reservoir located upstream from the Jilin accident site with the intention to dilute the pollution. No information was provided on the quantity of water released.

Additional actions on pollution control were led by SEPA with the support of the China Academy of Environmental Sciences (CAES). As a test a mix of activated carbon, straw and maize stocks were put into cages and lowered into the river. The broom took up as much as 40% of the nitrobenzene from the polluted water passing through as estimated by CAES researchers. However, due to the icing process at the time, this method could not be further tested and used. Such a broom was used at the intake points for drinking water from the river to reduce the level of the contamination.

As a preventive measure, the provincial authorities of Heilongjiang have advised all the municipalities along the Songhua River as the pollution plume approaches to shut down all the operation of ground water supply within 1 km from the Songhua River. It also requested all the residents along the river to stop taking water from shallow drinking water wells within a 2 km distance from the river. Use of the river water for irrigation in agriculture is not in practice during this season. The industrial use of the river water is carefully assessed case by case by municipalities with the support of the environmental bureaux.

2.5 Information and communication

Information on official communication with the public on the spill at the initial stage of the accident was not provided to the mission team. However, available information showed unverified media information and initial lack of proper communication from government authorities had caused some panic.

At a later stage, the communication on the spill with the public was noticeably improved. Monitoring results were broadcasted via TV shortly after they were released by the monitoring centre of Heilongjiang province. The concentration of the pollutants has been broadcasted as it passed through Harbin every two hours. Press conferences were organized by the relevant local governments to inform the media of the situation. Information about the incident was posted on the web site of SEPA. However, they are all in Chinese and this prevented timely outreach to the international media and organizations.

As a lesson learnt, the existing system of communication of monitoring data should be revised to ensure critical information arrives to all pertinent response officials downstream of the river so that appropriate actions are taken to initiate response procedures. There is also an urgent need to ensure that adequate scientific information related to any substances released in the river be communicated to the appropriate authorities downstream so they know of any dangers posed and response required by them.

Information about the accident and pollution was shared at the highest level by the Chinese Authorities with the international community. On 26 November, SEPA informed UNEP about this incident through its permanent mission to UNEP in Nairobi. On the same day, SEPA also provided the same information to United Nations in China with the names of the chemicals released into the environment and monitored concentration. Since then, SEPA has regularly updated the UN on the situation of the pollution.

2.6 Medium and long term measures

While responding to the needs of emergency monitoring, SEPA has also started to develop plans for environmental impact assessment of the accident as well as measures for remediation of the damage. The Chinese Academy of Environmental Sciences will lead the assessment. The Ministry of Science and Technology, Ministry of Water Resources, Ministry of Agriculture, Ministry of Construction, Chinese Academy of Sciences and Heilongjiang and Jilin Provincial governments will participate in the efforts. The main work currently undertaken is systematic investigation of the ecological situation of the Songhua River, especially pre-pollution situation in tributaries. Samples of aquatic organisms, such as fish as well as sediment and ice were taken for testing. Drinking water sources and ground water safety is also considered in this assessment plan. The 11th five-year plan of Heilongjiang province is undergoing revision to take into account this incident and the impact assessment effort. SEPA experts requested UNEP's support and guidance especially on the methodologies and indicators for impact assessment and remediation.

Regarding the assessment of the Songhua River water quality for agriculture use, the monitoring of the Songhua River should be a basis to determine if the river water could be used for agricultural irrigation. Adequate monitoring of irrigation water should be undertaken to ensure that only water of acceptable quality is used for irrigation. Agricultural plant accumulation studies should be undertaken to ensure there is no accumulation of the pollutants in the agricultural products.

In the long term, China should consider developing air monitoring standards related to chemicals that are produced in bulk. While nitrobenzene is relevant to this incident an analysis of major chemical production facilities should be carried out with a view to identify which chemicals should be assessed for the development of air quality standards.

Substances that have a higher density than water will accumulate in depressions in the river and would also have different flow characteristics than river water. They may even stay in the vicinity of the initial incident. Denser material will flow around curves in the river in such a manner as to accumulate on one side or the other. This characteristic as well as the settling in depressions in the river or upstream close to the site of the incident may be useful if physical removal and treatment is considered. If treatment is considered then there are several options for nitrobenzene including incineration and biological treatment.

Great care must be taken in the spring when the ice thaws out. The frozen pollutants in the ice will become liquid and gas and the denser liquid that may have stayed in the bottom layer upstream may become mobile as the water flow increases. There should be an intense monitoring programme during the thaw of the ice.

Any related historical data for the entire river basis would be useful to understand the existing ecological conditions and pressures in the entire river basin. This would serve as input to any planned studies.

In terms of aquatic toxicity assessment, the mission team provides the following technical suggestions:

- Aquatic toxicity studies of organisms found in the Songhua River should be undertaken using the range of chemicals that were introduced to the river through this accident. Because of various limitations (budget, capacity, large number of organisms, single and combined chemicals studies etc.) and vast amount of work that is required over a long period of time, it is suggested that some critical criteria be identified to determine which organisms and which chemicals should be targeted first. Important criteria should include: toxicity of the chemical and organisms that are a direct or indirect food source for humans. Key general indicator organisms could also be used for comparison purposes. Planned studies should consider synergistic toxic effects of the chemicals released in this accident.
- As a preparedness measure, aquatic toxicity research should be promoted for other chemicals that are produced in a large scale close to the Songhua River. Consideration should be given to promoting and facilitating such studies in other rivers along which there are significant chemical production facilities. The private sector involved with the production of such chemicals may be interested in supporting such work.
- Acute and chronic toxicity work could be supported by in-situ live testing in the river such as keeping live organisms (e.g. indigenous fish and indicator species) in the river and observing the impacts including taking bioassays. This would give immediate information on grave toxicity situations.
- Long term studies on bioconcentration and bioaccumulation in aquatic organisms of the substances released by the accident is necessary in order to take appropriate measures to protect the population.
- Aquatic toxicity studies should consider background samples (upstream of the industrial area of the incident, control samples (clean water), site samples, controlled substances added to background samples, and controlled levels of contaminants added to clean water. These should be considered when doing standard methodology for toxicological studies.

The UNEP mission team believes that further impact studies would be important to determine what additional support is required by the population directly and indirectly affected by the pollution incident. As the substances involved are carcinogenic and have various vectors, epidemiological studies on acute, short, medium and long-term impacts on human health should be conducted. This should investigate all routes of human exposure including river water, ground water, drinking water, air and soil. It is advised that this should be done in close working collaboration with internationally recognized organizations, such as the World Health Organization.

The UNEP mission team also provided suggestions on addressing the awareness, preparedness and response to environmental emergencies in a systematic manor by building contingency plans and applying methodologies developed by UNEP and used widely.

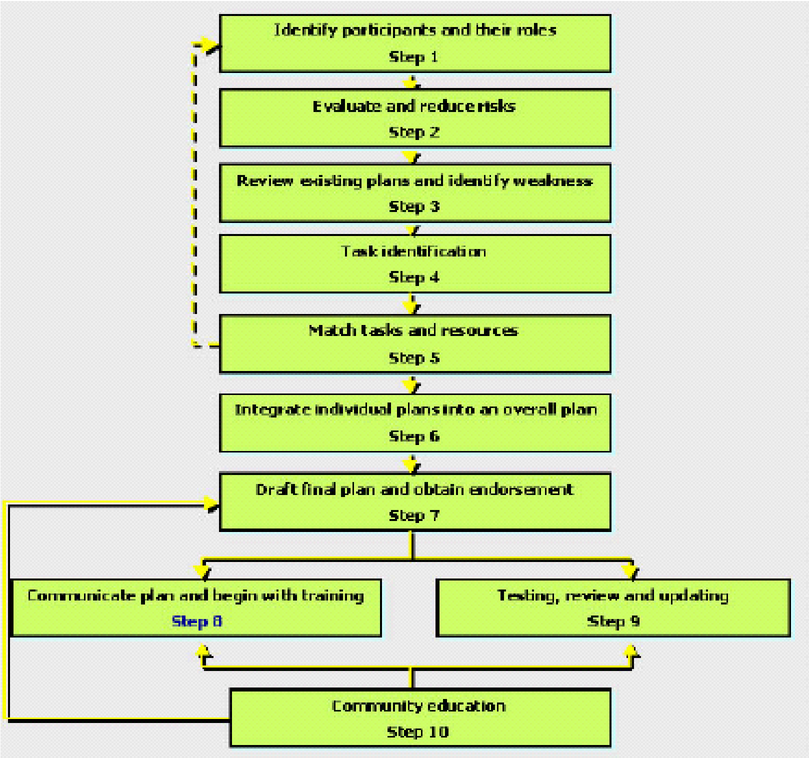
The response to disasters is usually characterized by the urgent need for rapid decisions accompanied by acute shortage of trained personnel, material and time to carry out the decisions effectively. Environmental emergencies feature similar characteristics.

The goal of an environmental contingency plan is to provide an adequate response to accidental releases of pollutants, such as in the Songhua River Spill case, within the mandate limitations of an environmental agency, and at the same time, be complementary to an overall disaster plan.

When it comes to environmental emergencies, many disaster plans tend to be silent on the topic of environmental aspects of emergencies. Some disaster plans appear to be prepared with an assumption that environmental aspects would be taken care of by appointing, to a decision-making group under the disaster plan, a representative from an agency with responsibility for environmental programmes without elaborating on the expected participation of the representative, and a few disaster plans describe tasks for key members, assigned to decision-making groups created by the plan for the purpose of resolving issues, in only vague terms.

Environmental contingency plans tend to fall into the category known as 'agent-specific' plans and this group of plans usually cannot be expected to address matters beyond the mandate of the host agency. Environmental agencies are usually responsible for establishing and enforcing environmental standards, and these agencies normally do not have the authority to effect evacuations, rescue, crowd control or other emergency services that may come into play in large scale events even if the event at hand may be described by some observers as an environmental disaster. Environmental agencies, thus, generally need to rely on civil defense, health or other emergency services to deal with issues that are beyond their own mandate. An effective partnership between various contingency plans and between various agencies for complex events is therefore crucial.

The response to environmental emergencies requires coordinated response as well as good preparedness from local communities. APELL programme of UNEP (Awareness and Preparedness for Emergencies at Local Level) gives local people the information and decision-making structure to address the hazards in their community. APELL is a **local process** of hazard communication and coordination 'owned' by the community and its rescue services. UNEP and national and international bodies have **programmes** to promote and facilitate this local level process. A ten-step process to implement APELL is illustrated below.



Source: UNEP

2.7 Cooperation and coordination with the Russian Federation in monitoring and response

The cooperation and coordination between China and Russia over the incident has reached the highest level of both governments. Both the President and the Prime Minister extended their apologies to the Russian government. The Chinese president Hu Jintao said “We will take all necessary and effective measures and do our utmost to minimize the pollution and reduce the damage to the Russian side” when taking to Russian officials. SEPA officials met with the Embassy of the Russian Embassy and informed them of the pollution incident. China has provided relevant information to the Embassy of the Russian Federation in China on a daily basis. The team did not verify when this information sharing was initiated.

Russian government provided a list of chemicals to China and requested that they be monitored. SEPA experts undertook the tests and reported back to Russian side. On 28 November, a Russian delegation of 7 people from the Federal Ministry of Natural Resources and Khabarobsk region arrived in Harbin.

China and Russia agreed on a joint monitoring team whereby Russian experts and officials travelled to China and would take samples and test the concentration of benzene and nitrobenzene. On 1 December samples were taken at the Mulan cross-section with the participation of the Russian experts. The samples were divided into three portions. One was tested in China with the observation of Russian experts; one was taken to Russia for testing; and one was kept in storage for future use. Russian experts then took part in the sampling and testing at Jiamusi cross-section.

On 13 December, SEPA informed UNEP mission team that an agreement on joint monitoring of the pollution caused by the Jilin chemical accident was reached between China and Russia. On 14 December joint monitoring continued at Tongjiang cross-section and will be carried out at the rest of the monitoring points within China and in Russia. The joint sampling at the pollution plume position is carried out twice a day. On the basis of the Joint Emergency Response Monitoring Plan on Water Quality of the Songhua River signed between China and Russia both countries will strengthen joint monitoring.

At the debriefing meeting with SEPA on the afternoon on 16 December, the mission team was informed that China was donating equipment and materials to assist Russia to respond to the potential damage and risks, including 6 pieces of monitoring equipment, 150 tonnes of activated carbon and 6 air compressors.

After the mission additional information provided indicated that upon the request of Russia, Heilongjiang Province began the construction of a diversion dam on the Fuyuan waterway on December 16. At around 12 A.M. of December 21, the diversion dam on Fuyuan waterway was successfully closed. Immediately after the closure, Chinese and Russian experts jointly conducted water sampling at the spots in front and behind the dam. The dam prevents the polluted water from flowing through the intakes of drinking water in Khabarovsk City and effectively reduced the pressure on the city to prevent and control the water pollution. The dam will also protect the Russian resident along the lower reaches of the Ussuri River from being affected by the pollution. The pollution plume will not flow through the lower reaches of Xiaohezi of Fuyuan county, therefore Chinese residents living in this area will also not be affected by the polluted water. The dam will protect the water quality on the Fuyuan waterway.

2.8 Limitations to the mission

During the field mission, a task force appointed by the State Committee dealing with the Songhua River Spill, was conducting investigations at the site of the explosion in Jilin. Therefore, the UNEP team was not able to visit the accident site. A site visit can help clarify the causes of the accident, immediate response measures as well as an indication of the contingency plans and measures in place at the site. The conclusions of the Task Force should be made public to ensure proper information sharing with the affected population and to assist the wider community of emergency responders to improve overall awareness and preparedness.

The UNEP team reached the affected cities only during week 4 after the disaster. By this time, it was hard to find out when certain measures had started and what response time various actors required.

The UNEP team did not take any sampling or referencing of information. All information contained in this report reflects what has been obtained through interviews with officials of SEPA, local and provincial environmental protection bureaux and local and provincial monitoring centers. In particular, any monitoring data should be regarded as secondary data as provided by SEPA.

In addition, the terms of reference excluded response measures taken by local, provincial and national agencies, including civil defense, health, army, police, fire brigade, etc. This document is therefore limited to the mandate and scope as requested by the State Environmental Protection Administration.

3. Conclusions and recommendations

3.1 Conclusions

The Songhua River Spill is probably one of the largest transboundary chemical spill incidents in a river system in recent years.

It is clear that, during the initial response phase, government communication and information sharing with the general public was not adequate enough to ensure appropriate responses of the affected population. Further investigations are needed to clarify whether existing early warning systems and contingency plans were sufficient. Implementation of programmes such as UNEP's Awareness and Preparedness for Emergencies at Local Level (APELL) have proven to contribute to the risk reduction of industrial accidents. China may wish to explore the possibility of putting a national APELL type programme in place.

Furthermore an analysis of the internal risk management practices of industry should be undertaken through a random sample of industries so as to assess the state of preparedness and identify capacities and legislations/regulations required to minimize the risks. UNEP is ready to assist the Government of China in this regard.

By the time the affected areas were visited, SEPA demonstrated the ability to mobilize and coordinate sufficient capacity to carry out monitoring and chemical analysis (including the relocation of critical high performance equipment and related scientists) to monitor, predict and communicate the movement of the pollution plume.

The Songhua River Spill is of major transboundary and international significance. It is a common practice that in transboundary incidents sampling and analysis are undertaken by all countries involved and affected as well as by an independent internationally recognized laboratory. If China agrees with this strategy UNEP will be happy to assist by identifying an appropriate international laboratory.

The recently established joint monitoring programme between China and Russia is an encouraging step in furthering multilateral cooperation on shared water resources. The establishment of an international commission to coordinate joint efforts of improved river basin management – such as the Rhine Commission established following the Basel chemical spill in 1986- has proven to be a successful approach.

3.2 Recommendations

Environmental impacts on the site of the accident, including any potential sources of groundwater, surface water and soil contamination and air pollution should be identified and appropriate mitigation and decontamination measures implemented as a matter of urgency.

A comprehensive investigation into the causes and response to the Jilin accident and subsequent Songhua River Spill should be carried out in order to draw lessons for the national and international community to prevent similar situations from occurring. Such investigation should cover at least the following areas: 1) communication and information sharing, 2) response time and effectiveness; 3) environmental contingency planning.

The United Nations Environment Programme suggests that both China and Russia provide access to independent and impartial sampling and chemical analysis of the River Spill.

Lessons learnt from the Jilin accident should be incorporated into policy, legislation and enforcement, contingency plans, and response capacity. This requires serious efforts in capacity building and appropriate allocation of resources and responsibilities. Also, these lessons can serve the international community to improve prevention, preparedness and response capabilities.

UNEP can offer its international experience and expertise to support the Chinese Government, and in particular SEPA, with such a lessons learnt exercise and follow up activities.

Regular and emergency monitoring of surface water quality should be based on a comprehensive and rational risk inventories of hazardous substances used in industrial processes and storage facilities in the river basins.

The current monitoring regime should be expanded to include appropriate measuring of air quality. In particular, concentrations of organic compounds should be monitored taking into consideration rising temperatures and increased evaporation of the substances spilled.

Riparian states of the Heilongjiang/Amur River Basin should consider the establishment of an international commission with the overall objective of the sustainable development of the River system, including the protection of ecosystems. Activities of the Commission can include joint monitoring and information sharing, implementation of work programmes, geographic information systems, risk inventories and clear procedures for early warning and response.

Annex 1 Itinerary of the UNEP Mission on Songhua River Chemical Spill

Friday 09 December 2005

- Travel to Beijing, China

Saturday 10 December 2005

- Arrival Beijing, China and assembly of mission team
- Team meeting at UNEP Beijing office
- Meeting with UN Disaster Management Team – China
- Meeting with Vice-Minister, Zhu Guangyao, International Cooperation, State Environmental Protection Administration
- Travel to Jiamusi city, Heilongjiang Province

Sunday 11 December 2005

- Briefing on overall situation of pollution monitoring
- Site visit to Songhua River sampling location, Jiamusi (observed sampling).
- Visit the Jiamusi Local Environmental Monitoring Centre and briefly met two experts of the Russian Monitoring Team
- Meeting with the head of Jiamusi Local Environment Protection Bureau

Monday 12 December 2005

- Technical discussion with Chinese experts including representative of the Chinese Research Academy of Environmental Sciences, Jiamusi Local Environmental Monitoring Centre, and Jiamusi Local Environment Protection Bureau
- Meeting with Vice Minister Zhang Lijun
- Visit to Jiamusi Number 9 Water Plant (Drinking Water Treatment Plant - ground water) located about 1.5 kilometres from the Songhua river.

Tuesday 13 December 2005

- Travel to Harbin city
- Meeting with Heilongjiang Provincial Environmental Protection Bureau

Wednesday 14 December 2005

- Visit to Heilongjiang Provincial Environmental Monitoring Centre, including the laboratories and meeting with the Deputy Director.
- Meeting with the Harbin Local Environment Protection Bureau
- Visit to the Harbin water source area (not possible due to the condition of the road)
- Travel to Beijing
- Report writing

Thursday 15 December 2005

- Report writing and further background research
- Meeting with State Environmental Protection Administration collect and verify information

Friday 16 December 2005

- Report writing
- High-level meeting between Vice Minister Mr. Zhu Guangyao, International Cooperation, SEPA and UNEP Director, of Technology, Industry and Economics
- Meeting with UN Disaster Management Team
- End of mission

Annex 2 Fact sheet of Benzene, Nitrobenzene and Aniline

BENZENE

1. Chemical data

- Molecular formula: C6H6
- Molecular mass: 78.11
- Physical form: clear, colourless liquid,
- highly volatile, flammable liquid
- CAS 71-43-2
- Boiling point: 80°C
- Melting point: 6°C
- Relative density (water = 1): 0.88
- Solubility in water, g/100 ml at 25°C: 0.18
- Vapour pressure, kPa at 20°C: 10
- Relative density of the vapour/air-mixture at 20°C (air = 1): 1.2
- Relative vapour density (air = 1): 2.7
- Flash point: -11°C c.c.
- Auto-ignition temperature: 498°C
- Explosive limits, vol% in air: 1.2-8.0
- Octanol/water partition coefficient as log Pow: 2.13
- Benzene has a characteristic odour
- Odour threshold in air is 12 ppm (Amoore and Hautala, 1983), 4 ppm (Jex and Wyman, 1996), 1.1 ppm (Gusev, 1965), 1.4-84 ppm (Ruth, 1986).
- Odour threshold in water is 10mg/L

2. Toxicity

- Benzene is absorbed rapidly by ingestion and inhalation. Absorption through the skin is slow and is unlikely to cause systemic toxicity
- Exposure to high concentrations of benzene can cause death by respiratory depression or cardiac arrhythmias
- At concentrations of 20,000 ppm and upwards death can occur within 5-10 min
- Ingestion of 8.8 - 30 g of benzene has been fatal
- Individual susceptibility to benzene toxicity is variable.
- The most significant chronic health effects are haematotoxicity, immunotoxicity and carcinogenicity.
- Benzene is a genotoxic carcinogen in man
- Benzene crosses the placenta

3. Environmental levels

- Major sources of benzene in water are: atmospheric deposition, spills of petrol and other petroleum products, and chemical plant effluents.
- Levels of up to 179 µg/litre have been reported in chemical plant effluents.
- Levels between 0.2 and 0.8 µg/litre were reported in the Rhine in 1976
- Levels of 0.03–0.3 mg/litre were found in groundwater contaminated by point emissions.
- In Canada, benzene was detected in 50–60% of potable water samples taken at 30 treatment facilities; mean concentrations ranged from 1 to 3 µg/litre (maximum 48 µg/litre).
- In the USA estimated that approximately 1.3% of all groundwater systems contained benzene at concentrations greater than 0.5 µg/litre (highest level reported 80 µg/litre).

4. Environmental fate

- Due primarily to volatilization, the residence time of benzene in water is a few hours, with little or no adsorption to sediments. In water benzene has an estimated half-life of 4.8 hours (1 meter deep at 25º C)
- Under aerobic conditions, benzene in water or soil is rapidly (within hours) degraded by bacteria, however, under anaerobic conditions (for example, in ground water) bacterial degradation is measured in weeks and months rather than hours. In the absence of bacterial degradation benzene can be persistent.
- Benzene is not expected to be adsorbed by sediments; does not bioaccumulate in the food chain
- Benzene in air exists predominantly in the vapour phase, with residence times varying between a few hours and a few days, depending on environment and climate, and on the concentration of hydroxyl radicals, as well as nitrogen and sulfur dioxides.
- It can be removed from air by rain, leading to contamination of surface and ground water.

NITROBENZENE

1. Chemical Data

- Nitrobenzene $C_6H_5NO_2$
- Molecular mass: 123.11
- Colorless to pale yellow oily liquid with an odour resembling that of bitter almonds or "shoe polish."
- Boiling point: 211°C
- Melting point: 6°C
- Relative density (water = 1): 1.2
- Solubility in water: 1900 mg/litre at 20 °C
- Vapour pressure, Pa at 20°C: 20
  Relative vapour density (air = 1): 4.2
- Relative density of the vapour/air-mixture at 20°C (air = 1): 1.00
- Flash point: (c.c.) 88°C
- Auto-ignition temperature: 480°C
- Explosive limits, vol% in air: 1.8-40
- Octanol/water partition coefficient as log Pow: 1.86

2. Toxicity

- Readily absorbed by ingestion, inhalation and dermally.
- Converts haemoglobin to methaemoglobin, resulting in cyanosis and features of hypoxia
- May cause haemolytic anaemia, especially in those with glucose-6-phosphate dehydrogenase deficiency (G6PDD)
- Onset of toxic effects may be rapid or may be delayed for up to 12 hours after exposure.
- Infants are particularly vulnerable to methaemoglobinaemia
- Use of ethanol enhances toxicity.

3. Environmental levels

- Concentrations of nitrobenzene in environmental samples such as surface water, groundwater and air are generally low, in the order of .1–1 µg/litre).
- One of the highest levels reported was 67 µg/litre, in the river Danube, Yugoslavia, in 1990.
- Nitrobenzene was not detected in any surface water samples collected near a large number of hazardous waste sites in the USA (reported in 1988).
- Based on limited data, it appears that there may be greater potential for contamination of groundwater than of surface water; several sites measured in the USA in the late 1980s had levels of 210–250 and 1400 µg/litre (with much higher levels at a coal gasification site).

4. Environmental fate

Water

- Not likely to bioaccumulate in aquatic organisms
- Volatilizes slowly from the water phase; transfer from water to air will be significant, but not rapid.
- Does not adsorb strongly to suspended soils and sediment in water
- Data on evaporation of nitrobenzene from water bodies appear to be somewhat conflicting, with a computer model predicting volatilization half-lives of 12 days (river) to 68 days (eutrophic lake).
- The shortest estimate cited in the literature was 1 day (from river water); in another study of experimental microcosms, simulating land application of wastewater, nitrobenzene was reported not to volatilize but to be totally degraded.
- Biodegradation occurs under aerobic and anaerobic conditions
- Typical concentrations of nitrobenzene in surface waters range from 0.1 to 1 µg/litre; however, concentrations of up to 67 µg/litre were reported in the river Danube, Yugoslavia, in 1990 (EHC).

Air

- The vapour pressure of nitrobenzene of 20 Pa at 20 °C indicates that nitrobenzene may be slightly volatile. Washout by rainfall (either through solution in raindrops or by removal of nitrobenzene sorbed onto particulates) and dryfall of particulates is negligible. Atmospheric residence time was estimated to be 190 days.

Vapour densities reported for nitrobenzene relative to air range from 4.1 to 4.25. Removal processes for nitrobenzene in air may involve settling of vapour due to its higher density relative to air.

ANILINE

1. Chemical Data

• Aniline: C_6H_7N • Molecular mass: 93.1 • Volatile, flammable, colourless, oily liquid that darkens on exposure to air and light. • Peculiar odour and burning taste • Boiling point: 184°C • Melting point: -6°C • Relative density (water = 1): 1.02	• Solubility in water, g/100 ml at 20°C: 3.4 • Vapour pressure, Pa at 20°C: 40 • Relative vapour density (air = 1): 3.2 • Flash point: 70°C c.c. • Auto-ignition temperature: 615°C • Explosive limits, vol% in air: 1.2-11 • Octanol/water partition coefficient as log Pow: 0.94

2. Toxicity

- minimum toxic dose not been defined, 25 to 65 mg orally can cause significant elevation of methaemoglobin levels
- no-effect level in humans following oral administration is 5 to 15 mg (0.07 to 0.21 mg.kg-1)
- mean lethal dose by ingestion is humans is estimated at between 15 and 30 g
- The lowest fatal dose reported in humans is 1 g orally
- Continuous exposure to small doses of aniline may cause anaemia, lethargy, digestive disturbances and headache

3. Environmental Level

- Completely degraded by a bacteria in river mud in 20 days.
- 75-99% Mineralization occurred in 21 days in water from an oligotrophic lake and 40-60% of the aniline degraded in 1 day in river water and seawater when incubated at 30 deg C.
- Degradation occurred in Nile River water after a 3 day lag.
- The half-life of aniline in the Rhine River was 2.30 days as determined by concentration reduction between sampling points.
- Biodegraded approximately 100% in upper surface water from the Naka River and approximately 70% in lower reaches over a 7 day incubation period.
- Completely degraded by pond water near an industrial factory in Osaka, Japan over a 7 day incubation period, but was not degraded in water from a non polluted botanical pond and rice paddy.

4. Envitonmental Fate

- The effects of low temperature and accelerated soil soln contact on soil adsorption of labile organic chemicals were investigated in lab experiments.
- Kinetics of adsorption and degradation were measured for C labelled aniline, benzoic acid, phenol, and diuron in the soln phase at 3 and 22 deg C.
- In the initial stages of reaction, the adsorption of all 4 chemicals was instantaneous at both temperatures under accelerated soil and soln mixing.
- A steady state was observed after the onset of equilibrium for the adsorption reaction for all cmpd within 10-30 min. Its length varied according to the expected order of susceptibilty to microbial degradation, ie, diuron > aniline > phenol greater than or equal to benzoate.
- The steady state period without or in combination with low temperature could be used to obtain adsorption measurements in microbially active systems.
- Minimal interference from solute transformations in the soln phase would be expected from soil microoganisms.

Water

Not likely to bioaccumulate in aquatic organis

- Undergoes rapid biodegradation

- harmful to aquatic life in high concentrations; it is not expected to concentrate in the food chain

Air

- Reacts with photochemically produced hydroxyl radicals with an estimated half-life of 3.3 hours

Fact Sheet References

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Annex 3 Key resource persons to the mission

Mr. Zhu Guangyao, Vice Minister, International Cooperation, SEPA.

Mr. Zhang Lijun, Vice Minister, Pollution Control, SEPA.

Mr. Yue Ruisheng, Deputy Director General, Department of International Cooperation, SEPA.

Ms. Zhang Jieqing, Director, Divisions of International Organizations, Department of International Cooperation, SEPA.

Prof. Shu Jianmin, Deputy President, Chinese Research Academy of Environmental Sciences.

Prof. Liu Zhengtao, Executive Director, Key Laboratory for Ecology Effects, and Risk Estimation of Chemicals, SEPA, Chinese Research Academy of Environmental Sciences.

Mr. Li Guo Gang, Deputy Director, China National Environmental Monitoring Centre.

Mr. Cao Liping, Division Director, Areal and Ecological Inspection Division, Bureau of Environmental Protection Inspection, SEPA.

Mr. Guo Jing, Director, The Secretariat, China Council for International Cooperation on Environment and Development, SEPA.

Mr. Wang Jian, Deputy Director, Jiamusi Environmental Protection Bureau

Mr. Li Ping, Vice Director and Senior Engineer, Environmental Protection Bureau of Heilongjiang Provice, P.R. China.

Ms. He Xiaoying, Translator and Interpreter, Department of International Cooperation, SEPA, P.R. China.

Dr. Zheng Binghui, Chinese Research Academy of Environmental Sciences, Institute of Water Environment.

Mr. Sun Qingmin, Chief of Section, Account, Heilongjiang Province Environmental Protection Agency, Division of International Affairs.

Mr. Yufei Zhang, Deputy Director, Environmental Protection Bureau, Harbin National Environmental Industry.

Mr. Shi Lian Hua, Department Chief, Outward Cooperation Department, Environmental Protection Bureau of Harbin Municipality Government.

Prof. Chen Aifeng, Deputy Director, Heilongjiang Environmental Monitoring Centre.

Mr Khalid Malik, UN Resident Representative China

Mr. Michel Gabaudan, Head UN Disaster Management Team/ UNHCR China

Mr. Harold Randall, UNICEF China

Mr. Henk Bekedam, WHO Representative China

Mr. Adam Craig, WHO China

Mr. Yoshihiro Takashima, WHO China

Annex 4 UNEP Field Team

Mr. Leo Heileman, Head of the Implementation Unit, Production and Consumption Branch, UNEP Division of Technology, Industry and Economics, Team Leader;

Mr. Xuemin Shao, UNEP representative in China;

Mrs. Wei Zhao, Regional Industry Officer, UNEP Regional Office for Asia and the Pacific;

Mr. Rene Nijenhuis, Programme Officer, Joint UNEP/OCHA Environment Unit.