TURKEY EARTHQUAKE
August 1999

UNDAC MISSION

EMERGENCY ASPECTS OF ENVIRONMENTAL IMPACTS

INTERNAL REPORT

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INTRODUCTION

A major earthquake hit North-Western Turkey at 03.02 a.m. on 17 August 1999. Epicentre was located in the province of Izmit, some 125 km south of Istanbul, on the Sea of Marmara. The earthquake was one of the most powerful in Turkey in the last 20 years. The event and its aftershocks had devastating effects on the provinces of Izmit, Yalova, Sakarya, Istanbul, and others. The earthquake was felt in provinces as far away as Ankara, depicting a belt starting from the Marmara Region in the northeast of the country all the way into Central Anatolia. The area is the most densely populated of the country, and holds many industrial sites.

As of 29 August 1999, the number of dead reached almost 14,000 and the number of injured – more than 27,000.

Damage to buildings and infrastructure has been extensive. In some locations more than 70% of buildings were destroyed. Some industrial enterprises were reported to be damaged.

The Government of Turkey established a Crisis Coordination Centre under the authority of the Prime Minister. National authorities were directing assistance to victims and carrying out a major search and rescue (SAR) operation.

On 17 August 1999, OCHA activated its Disaster Response System, which includes the alert, mobilization and deployment of the United Nations Disaster Assessment and Coordination (UNDAC) team, the dispatch of disaster management staff to support the Office of the UN Resident Coordinator in Ankara, the alert of the International Search and Rescue Advisory Group (INSARAG) and the support to the establishment of an On-Site Operations Coordination Centre (OSOCC). OCHA was also coordinating information sharing with relevant organizations.

Immediately on 17 August 1999, when initial information on this disaster arrived, the Joint UNEP/OCHA Environment Unit contacted official National Focal Points for Environmental Emergencies in potential donor countries. Their attention was drawn to a large fire at the Tupras Oil Refinery in Izmit. All correspondence was routinely copied to UNDP in Ankara, UNEP HQ in Nairobi, UNEP Office in Geneva, and OCHA in Geneva.

On the same day, the Joint Unit highlighted a risk of damage to different industrial sites, and requested available information from the Turkish authorities.

Also on 17 August 1999, the Joint Environment Unit approached a number of donor countries with an urgent request to provide assistance to Turkey in terms of special fire fighting chemical additives and foams.

UNDAC Team arrived in Istanbul on 17 August 1999. The Head of the Joint UNEP/OCHA Environment Unit was dispatched to Turkey on 19 August, to provide a general support to the UNDAC Team, as well as to address emergency aspects of environmental impacts. He stayed there till 28 August.

While on UNDAC mission, the Head of the Joint UNEP/OCHA Environment Unit jointly with some other Team members visited all major affected areas, including Izmit, Sakarya, Golcuk, Yalova and Degrimendere, as well as two damaged industrial enterprises – the Tupras Oil Refinery and the AKSA chemical plant. The Turkish authorities also organized a tour of most affected locations by helicopter, as well as a visit of the Izmit Bay by boat.

Close contacts were established with the Turkish Ministry of Environment, as well as with UNDP staff in Istanbul and UNDP Office in Ankara. Meetings were held with the Turkish Under-Secretary for Environment, the State Minister for Coordination of Disasters, and provincial environmental authorities.

This report is based on observations during several field visits, as well as on information received during the mission from Turkish authorities, international experts, and local representatives.

DAMAGE TO INDUSTRIAL INSTALLATIONS

The affected territory is highly industrialized. Up to now, two cases of important damage to industrial sites are known. Firstly, a large fire at the Tupras Oil Refinery in Izmit. Secondly, a toxic leak at the AKSA Chemical Plant in the district of Yalova.

FIRE AT THE TUPRAS OIL REFINERY

The Tupras Oil Refinery is situated on the outskirts of the town of Izmit, approximately 125 km South of Istanbul, in a flat area on the bank of the Izmit Bay, which forms a part of the Marmara Sea.

On 17 August 1999, the earthquake caused 3 simultaneous fires at the refinery in different locations. A warehouse caught fire, a tall chimney collapsed and hit furnace and pipelines, and several tanks with different types of naphta were on fire. Electrical supply was disrupted by the earthquake. A pipeline, bringing fresh water from a nearby lake, was broken. All communications, including GSM, went down. Roads at the refinery were damaged. Under these conditions, fire fighting was extremely difficult. To support Turkish fire fighters, several countries sent their teams. Water bombing airplanes from a number of countries also arrived. It should be mentioned, however, that water dropping was highly controversial, and not recommended by many experts also on account of using too much water.

This fire continued till 22 August 1999. According to the management of the refinery, the total amount of oil products burnt (mostly naphta) was about 30,000 tones. No crude oil and leaded gasoline were burnt. 6 large storage tanks were damaged/destroyed by the fire.

As a result of the disruption of electrical supply, the only waste water treatment plant stopped working, became flooded with water from fire fighting operations, and an unknown amount of mixture of various oil products escaped into the sea through the outlet. The necessary response measures were taken. Barriers were put in the sea, and 4 skimmers were used. A British Team from the South Hampton Spill Response Centre arrived to support clean up operations. About 600 tons of oil were recovered.

At present, the situation is generally under control. All fires were put out. There is no further immediate risk from marine environment point of view, as the waste water treatment plant is working again, and oil is not escaping to the sea.

However, the management of the refinery considers the situation as still highly hazardous. As a result of the earthquake, floating roofs at 45 tanks out of 80 sunk totally or partially. Contents of the damaged tanks (such as crude oil, gasoline, etc.) are completely exposed to the atmosphere. A single lightning may be enough to cause a new fire(s) at any moment. At the same time volatile organic compounds (VOC) are evaporating and causing serious air pollution. The necessary steps are being taken to prevent another accident. Oil products are being relocated inside the refinery. A special Dutch team is providing assistance. However, this process is very slow, because a great care should be taken with regard to sunken floating roofs. Oil is also being pumped to a tanker. Turkish fire brigades are permanently present at the refinery.

The refinery's management has appealed for urgent international assistance to help prevent a possible major accident. A number of needs have been highlighted.

Environmental impacts of the fire at the Tupras Oil Refinery

Air Pollution

The fire, which burned approximately 30,000 tones of oil products, led to the release of combustion products and pollutants into the atmosphere. Sulphur content in naphta is low. Consequently, SO2 pollution would not be important. Anyway, emissions of sulphur dioxide can be directly derived from the sulphur content of burnt oil products.

Emissions of nitrogen oxides depend strongly on the combustion conditions, particularly the flame temperature and the residence time. Under atmospheric conditions the emission factor is usually in the range 2-15 g/kg oil, expressed as NO2 equivalents.

Emissions of carbon monoxide and various other components, formed in the incomplete combustion, also depend very much on the burning conditions, but also on the type of fuel burned. Particularly conspicuous are the black soot particles, composed of elementary carbon, which are associated with high molecular-weight hydrocarbons, such as the polycyclic aromatic hydrocarbons.

Releases of air pollutants and toxic compounds can be estimated from the considerations above, and the amount of material which burned.

These emission numbers may be used to infer order-of-magnitude ambient concentration levels in air during the fire event, and long-term effects in relation to the deposition of these emitted amounts.

Atmospheric dispersion and air quality

The large amounts of heat released during the combustion causes strong entrainment of combustion air, which increases the turbulence and the mixing of the plume with the surrounding air. The buoyancy of the warm combustion gases and the entrained air causes a strong plume-rise effect. Visual observation confirm this, the plumes have been seen to have a strong rise. Under such circumstances, the combustion gases would not be normally observed at ground level near the fires, but the plume may touch the ground several kilometers downwind of the source.

The highest concentrations at ground level would therefore occur at distances several kilometers downwind of the fires, and will be determined by the emission source strength

in kg/s, the wind velocity and the vertical and the horizontal dispersion in the plume. The latter can be represented by a cross-sectional area, which is likely to be a few km^2.

The air quality closer to the sources is more likely to be affected by smaller fires, and from emissions in the smoldering stages of the fires, when the large-scale entrainment of air has ceased.

Consequently, some areas in Izmit and surrounding districts may have experienced significant concentrations of pollutants, including airborne particles, during the fires. Health effects would depend on several aspects, including the wind direction, which was changing.

A description of the relevant meteorological situation could be obtained from the Turkish Hydrometeorological Service and /or regional and local meteorological authorities, including information on direction and speed of wind during the fire, and precipitation (if any). According to visual observations, it was not raining in the area during the period of fire.

Deposition and Soil Contamination

The airborne contamination will eventually settle into the surrounding soil and fresh water reservoirs. Soil pollution may further lead to contamination of agricultural products (including green vegetables), thus presenting a risk to human health. Lake pollution may cause contamination of drinking water.

In order to determine any effects of the releases of pollutants in Izmit, soil samples from some of agricultural areas should be taken for subsequent determination of the contamination levels by chemical analysis.

Marine pollution

The Izmit Bay, especially its part between Izmit, Golcuk and Yalova, is seriously polluted by oil, oil products and fuel. Most of this pollution is likely to originate from the refinery in Izmit as a result of the earthquake and fire fighting operations. Other pollution may come from different sources between Golcuk and Yalova, resulting from collapse of seashore in this area. Pollution from “traditional” land-based sources is also not excluded.

A film of oil products/light fuel on the water is omnipresent, almost uniform. Slicks of crude oil are sporadic. In some locations smell of gasoline is very strong. Coastline is polluted by oil at great distances. Crude oil is also found in small bays and harbors. Some bird life is affected by oil. No dead fish have been spotted. A great amount of rubbish is everywhere on the surface.

The Bay had been heavily polluted in the past. However, due to great efforts, the situation improved during last 5-7 years. At present, marine ecosystems of the Bay are very sensitive. That is why the current pollution is bringing a lot of damage. The affected area is very large, oil is moving and extremely difficult to control. Reportedly, some oil has already reached the Marmara Sea. Certain clean up operations are being carried out, with limited resources. However, it is extremely difficult, if not impossible to complete these operations before September, when fishing season starts. It means that fishery activities would be badly damaged, as selling fish would be prohibited.

In Degirmendere and its surroundings, parts of the shore collapsed into the sea. An area of several kilometres in length by 150m width of the foreshore involving parkland, large hotel, wharf area, cafeterias, shops, toilets and numerous cars, have now been consumed by the sea water. This may lead to seawater being polluted by various substances released from the above-mentioned sources. Chemical pollution could be expected but cannot be confirmed by visual observation alone.

A matter of strong concern is the fact that in many locations an active dumping of rubble from the destroyed human settlements into the sea has been underway, which would lead to pollution and long-term consequences for marine ecosystems. Dumping of rubble into the sea is aggravating the problem of oil pollution, as waste is covering sunken oil, which would remain trapped for a long time.

A petrol station on the shore in Degirmendere has been affected by the earthquake. As a result, two large underground containers (allegedly almost empty) are exposed to the seawater. Condition and number of other underground containers are unknown.

Scientists from the Istanbul University, Institute of Marine Sciences, are currently working on board of Research Vessel Arar, which recently came from the Black Sea, to assess pollution in the Izmit Bay. Turkish experts are taking samples of water, pollutants, fish, vegetation, bentos, etc. Analyses are performed at the Institute of Marine Sciences. All coast line is being inspected by smaller boats. However, the affected area is huge. It is physically impossible to constantly monitor this large territory. In this connection, satellite imageries of the Izmit Bay are urgently needed. They would greatly facilitate the work of specialists involved in the assessment and clean up operations.

TOXIC LEAK AT THE AKSA CHEMICAL PLANT

The AKSA Chemical Plant is producing artificial fibres. It is located on the seashore between Yalova and Topgular, approximately 25 nautic miles from Izmit. The earthquake damaged 6 storage tanks with acrylonitrile. At the same time, electricity supply was disrupted, water pipelines ruptured, and communications went down. About 6,000 tonnes of acrylonitrile escaped. It mostly evaporated, but also polluted soil and underground water, and leaked into the sea through a storm water channel. The chemical burned vegetation and killed all animals in a small zoo at the premises.

Information on this accident was released to the public. Consequently, the Army took a decision to evacuate population from surrounding areas.

Initially, the plant did not have enough manpower to deal with the accident, as personnel was occupied with their affected families and damaged/lost property. No external support was available for about 30 hours.

Two engineers from BP Amoco, United States, arrived sufficiently quickly on site, to provide advice and assistance. The Austrian Forces Disaster Relief Unit (AFDRU) dispatched a 5-member Chemical Safety Team, which stayed at the plant on 21-23 August 1999, and provided chemical safety during inspection and damage assessment, performed by local engineers. Representatives of the Turkish Ministry of Environment also arrived to support response activities.

Samples taken from the Izmit bay a few days after the accident did not show any pollution by acrylonitrile, possibly because of its fast decomposition in the marine environment.

It is estimated by the plant's management that around 100-300 tonnes of acrylonitrile may be still in the underground water. Reportedly, pollution is confined to the plant area, as a clay level is situated at the depth of 6 m, and local underground water currents prevent acrylonitrile to spread. 13 monitoring wells have been drilled to monitor the situation.

The plant's management has contracted a US company "Parametrics" to assess the situation, take and analyze samples of polluted soil and underground water, and recommend decontamination measures.

At present, polluted underground water is being sucked and treated. A problem still remains how to achieve full decontamination.

A research vessel from the University of Istanbul is present in the Izmit Bay. It is taking various samples, in particular, to determine any pollution by acrylonitrile.

The plant's management has already taken certain steps to improve prevention of accidents. In particular, rigid connections at storage tanks have been replaced with flexible ones. "Preservation" pools have been reinforced with plastic covers.

A contingency plan existed before the accident. However, it was designed for a possible fire, and not for an earthquake. This plan is now being revised.

By 26 August 1999, the plant's production capacity was restored by 50%. At the end of September, the plant became fully operational.

Lessons learnt by AKSA management include the following:
- underground installations should be minimized;
- diesel power supply should be increased;
- alternative systems should be put in place;
- flexible connections should be installed;
- both the plant's personnel and local population should be trained.

CONCLUSIONS

1. Most important known environmental problems, associated with the recent earthquake, are marine oil pollution, potential consequences of air pollution, and the current situation at the Tupras Oil Refinery.

2. Apart from the Tupras Oil Refinery and the AKSA Chemical Plant, there is no information on other important hazardous installations damaged. However, it is not excluded that some other affected industrial sites, including warehouses and storage facilities, may be identified at a later stage.

3. The Izmit Bay is seriously polluted by oil and oil products. Both the sea and coastline are contaminated. This situation should be considered as an emergency. Possible chemical marine pollution should not be ruled out. The need for international assistance to clean up the Izmit Bay is clear.

4. One of the most pressing problems is disposal of rubble. According to local authorities, dumping of rubble into the sea has been prohibited.

5. Some areas in Izmit and surrounding districts may have experienced significant concentrations of pollutants, including airborne particles, during the fire at the Tupras Oil Refinery. Soil and fresh water pollution is not excluded. Soil pollution may further lead to contamination of agricultural products (including green vegetables), thus presenting a risk to human health. Lake pollution may cause contamination of drinking water.

6. From marine pollution point of view, the situation at the Tupras Oil Refinery is under control. However, contents of the damaged tanks (such as crude oil, gasoline, etc.) are completely exposed to the atmosphere. Volatile organic compounds are evaporating and causing air pollution. A new fire could easily start practically at any moment. This situation should be considered as an imminent emergency. Urgent international assistance would be highly useful.

7. The situation at the AKSA Chemical Plant is under control. At present, there is no further leak of acrylonitrile.

8. The present report covers emergency aspects of environmental impacts of the recent earthquake, and does not specifically address possible long-term consequences and related rehabilitation.

RECOMMENDATIONS

1. It is recommended to focus urgent international environmental assistance to Turkey on clean up operations in the Izmit Bay, and prevention of a possible accident at the Tupras Oil Refinery.

2. It is suggested that the competent Turkish authorities continue assessing the situation in the Izmit Bay, and share results with the international community.

3. It is proposed that the competent Turkish authorities collect, as soon as possible, available information on the location of different types of production and storage of chemicals and hazardous substances in the area affected by the earthquake. It is also necessary to establish a roster of affected industrial facilities, assess the situation there, and draw up a plan for safe clean up and rehabilitation.

4. At the refinery, the soil contaminated with the heavier oils should be removed and disposed under controlled conditions or by incineration. The soil contaminated by the lighter volatile oil products should be remediated using in-situ methods. Furthermore, it is recommended to clean-up the surface contamination in the storage areas before using these areas for storage of oil products again.

5. It is also recommended to investigate potentially contaminated areas outside the refinery. In order to determine any effects of the releases of pollutants in Izmit, soil samples from some of agricultural areas should be taken for subsequent determination of the contamination levels by chemical analysis. Samples (0-25 cm) could be taken from different agricultural fields and private garden plots in the periphery of Izmit, at distances 3-15 km from the refinery. A nearby lake is used as the principal source of drinking water. Samples of water should also be taken to determine whether the lake has been polluted.

6. It is recommended that potential donor countries consider possibilities to provide an urgent assistance to Turkey in conformity with the following identified priority needs:

- long oil barriers;
- 2 large oil skimmers and/or oil pollution response teams with equipment;
- several pumps for seawater with capacity 1500 cubic m/hour (fresh water pipeline in Izmit is still not operational);
- 8-inch hoses (at least 12 km);
- large fire monitors;

- special fire fighting foam (reserves have been almost exhausted);
- satellite imagery of the Izmit Bay (use of such imagery will be left at the discretion of the competent Turkish authorities).

7. It is suggested that the competent Turkish authorities undertake a study on long-term environmental consequences of the recent earthquake. UNEP and other relevant organizations may be requested to provide assistance in terms of expertise.

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