



**United Nations Disaster Assessment & Coordination (UNDAC)**



**COTE D'IVOIRE  
URBAN HAZARDOUS WASTE DUMPING**

**11-19 SEPTEMBER 2006**

**UNDAC Team:**

Pierre GELAS (OCHA Regional Disaster Response Advisor, Nairobi) – Team Leader

Sander VAN DIJK (Environmental Expert, Netherlands)

Einar BJORGO (Mapping Specialist, UNOSAT/Norway)

Sally GRIFFITHS (OCHA FCSS Geneva)

With assistance from: Vincenzo ODDO (Medical Doctor, UNDAC member from Italy, based in Abidjan)

**Associate Members:**

Peter BAREMAN (Environmental Expert, Netherlands)

Rudolf WALDER (Hazardous Waste Expert, Switzerland)

## **Background**

According to various sources, hazardous substances were dumped from the vessel, 'Probo Koala' on or about 19 August 2006 at a number of sites in Abidjan, Cote D'Ivoire. Abidjan has a population of 4 million people.

Initially six people were reported to have died and several thousand sought health care through fear of contamination or inhaling fumes. Symptoms included intestinal and respiratory problems as well as nose bleeds, nausea and vomiting.

The Government of Cote d'Ivoire requested international assistance in dealing with the crisis on 4 September 2006. As a result of the crisis, the Cabinet was dissolved on 6 September 2006.

On 9 September, an UNDAC team was requested by the UN Humanitarian Coordinator in Abidjan, to assist the UN and national authorities in coordination of the response to the crisis.

## **Meetings & Activities of the UNDAC Team**

The UNDAC team was mobilized and deployed by the Field Coordination Support Section of the Emergency Services Branch of OCHA Geneva. Through the network of the joint UNEP/OCHA Environmental Emergencies Section, the Governments of The Netherlands and Switzerland provided additional environmental experts, which were associated to the UNDAC Team. The team arrived in Abidjan on Monday, 11 September, and undertook meetings with the acting UN Humanitarian Coordinator, representatives of the UN system in-country, national authorities dealing with the crisis, the EU-MIC Liaison Officer and the team of French technical experts deployed to assist with scientific analysis. A full list of those met with is attached (Annex I).

During its meetings with representatives of the UN system, the UNDAC team was requested to:

1. Assess situation, environmental impact, coordination mechanisms and UN response strategy
2. Support EC-MIC and government strategy to mitigate the impact of hazardous waste dumping
3. Support removal of hazardous waste through mapping of sites and making recommendations to national authorities and Civil Protection
4. Provide maps and information to relevant actors, including database of sites and the private company contracted by the government to carry out remedial action in order to facilitate their tasks in this process
5. To advise UN Country Team on medium- to long-term action for monitoring impact of dumping on the community and propose Plan of Action to improve humanitarian/environmental response for future possible technological disasters

The UNDAC team met regularly with the acting UN Humanitarian Coordinator and representatives of the UN system as well as the international humanitarian community in Abidjan to keep them abreast of the situation. In addition, UNDAC prepared a Question & Answer sheet for UN staff in Abidjan for informational and reassurance purposes.

## **Meetings with National Authorities**

### *Ministry of Environment*

A meeting with the Ministry of Environment identified the main priorities as:

1. Identification of all affected sites, including trucks used to transport the waste.
2. Removal of hazardous substances from sites.
3. Identification of two appropriate dumping sites: one for safe disposal of the hazardous waste; the second for general waste, since the main dumping site in Abidjan (Akouedo) was no longer deemed usable due to contamination.
4. Hazard mapping and monitoring of air and water (fresh and seawater).

*ONPC – Office National de Protection Civil*

The UNDAC team met daily with representatives of the ONPC as the focal point in the government in charge of identification and protection of contaminated sites. A lack of protective and appropriate technical equipment and expertise had hampered government efforts to carry out effective analysis of the hazardous waste (note: UNDP subsequently provided some protective equipment and material for fencing off sites to ONPC).

The ONPC was requested to gather information from all government entities to assist in analysis of the situation and identification of all sites, including trucks used to transport the waste. Maps were provided to ONPC and technical advice was given regarding their updating and the need for accurate hazard mapping as part of the clean-up operations.

These meetings were also attended by CIAPOL (the government entity dealing with anti-pollution) and CNTIG (Centre national de teledetection et d'information géographique – the national mapping authority).



*Interdepartmental commission*

Technical experts from the UNDAC team joined the OCHA Abidjan Head of Office at meetings of the interdepartmental commission dealing with the crisis at the Prime Minister's Office.

The UNDAC team was invited to send a representative to the meeting of government representatives and consultants which took place on 14 September at the Prime Minister's Office with the private company being contracted to dispose of the waste. The report of the hazardous waste expert on the UNDAC team, who attended this meeting, is attached (Annex II).

*Private Company contracted to clean-up polluted sites (Tredi)*

In addition to the meeting of the interdepartmental commission with the private company mentioned above, further members of the UNDAC team met with the Project Manager of the company (Tredi) at the ONPC on 16 September and subsequently for further meetings.

At the 16 September meeting, Tredi reported on their experience of this type of work and their strategy for the clean-up, starting with site visits and assessments. The UNDAC team provided database of sites and maps to assist Tredi in the formulation of their depollution strategy and for presentations to their operational teams arriving with the requisite equipment. Priorities were to be the sites at Akouedo and Abobe.

Tredi reported their intention to conduct the clean-up operations in an open and transparent manner, to include clear explanations to the local population of what and how they will do this. Protection of the population will be of paramount importance and they have requested the government to place at their disposal an ambulance, escort and other vehicles. They will endeavour not to move people away from sites if this is possible.

The clean-up operations commenced at Akouedo on Sunday 17 September and are expected to last six weeks. The waste will be treated and disposed of in France with adequate facilities and according to international standards of safety and tracking.

## Hazard Mapping

The UNDAC team mapping expert liaised with relevant GIS (Global Information System) and mapping entities in Abidjan, including OCHA, Centre national de teledetection et d'information géographique (CNTIG), and UNOCI GIS Unit. To support the UNDAC mission, UNOSAT provided maps produced in Geneva. Up-to-date maps were hardcopy printed by OCHA and CNTIG as well as posted on the internet.

On 12 September, the UNDAC mapping expert joined the EC-MIC Liaison Officer, the French team of technical experts and national technical authorities in visiting all known sites to produce a common map based on all available information.

Maps and site database were updated on a daily basis by UNDAC in collaboration with CNTIG, UNOSAT, CIAPOL and ONPC and have also been provided to the private company contracted to remove the waste to assist with their operations.



The report of the UNDAC mapping expert is contained in Annex III and maps in Annex IV.

## Technical Assessment Activities

On 13 September, the UNDAC team met with the French team of technical experts to review and discuss their findings. The UNDAC team technical experts were in agreement with the findings.

On 14 September, UNDAC team technical experts visited a number of sites with ONPC – Office National de Protection Civile - to further assess the situation.

The technical report of the UNDAC environmental experts is attached as Annex V (English plus summary preliminary findings in French). This provides an overview of the findings, indicative conclusions and recommendations of the team related to the environmental and health impacts. The joint UNEP/OCHA Environmental Emergencies Section, based at OCHA in Geneva, provided essential guidance and support on the environmental aspects of the UNDAC mission.

Extensive scientific support was received from various research institutions in the Netherlands, through the national Support Team for Environmental Incidents (BOT-Mi) and in particular National Institute for Public Health and the Environment (RIVM), National Poisoning Centre (NVIC) and National Institute for Surface Water and Waste Water (RIZA).

## Summary of Findings

- On or about 19 August 2006, hazardous waste was dumped at a number of sites in Abidjan, Cote d'Ivoire.
- On the night of 14-15 September, further dumpings were reported to have taken place.
- Up to 18 dumping sites have so far been reported, including trucks used to transport the waste, not all of which have been located. Further sites may yet be found.
- The ONPC (Office National de Protection Civile) is the government focal point and is charged with identifying, mapping and protecting all sites. However, in the current situation, capacity to carry out these tasks has been limited.
- The main chemicals found in the original waste are hydrogen sulphide (H<sub>2</sub>S), mercaptans, phenols, hydrocarbons (a mixture of paraffins, olefins, naphtenes and aromatics). These chemicals can be harmful to humans and the environment if serious exposure takes place.

- It is likely that evaporation of volatile substances occurred in the direct aftermath of the dumping, possibly resulting in serious or even life-threatening concentrations, however it is not known how many people were directly exposed.
- It is believed that three weeks after the dumping of the waste the concentrations of the concerned compounds in the air are low and no further adverse health effects are to be expected. However the chemicals, especially mercaptans, have strong smells at low concentrations. The smell is already detectable by the human nose at concentrations far below danger levels. This may give a false impression of toxicity.
- The government made available free health services for the population in the wake of the crisis. As at 18 September, it was reported that more than 44,000 people had sought medical consultations, 66 of whom were referred for further tests.
- Seven people are reported to have died, but no autopsies have been performed to verify cause of death.
- Local media fuelled public fear, including of UN national and international staff, through alarmist claims of health effects. This resulted in demonstrations and roadblocks which impeded access to some of the sites.
- The UNDAC team was well-received by the UN system and the information of the technical experts greatly assisted in analysing the situation and in supporting a more coordinated response, for short-, medium- and long-term strategy formulation. The initial findings of the technical experts made a great contribution to reducing the tension caused by the lack of objective and comprehensible information.
- Misinformation about UN role in peace process may hamper future activities of ONUCI and UN system.
- An experienced private company, Tredi, has been contracted by the government to perform the clean-up operations which commenced on Sunday 17 September at the Akouedo site and will last approximately 6 weeks. The provision of maps by UNDAC was greatly appreciated for their activity planning.
- Provided the clean-up operations are carried out in accordance with accepted technical standards, no further impact on health or the environment should be expected.
- Analysis indicates that no substance remaining in the hazardous waste would be toxic in the drinking water in the concentrations to be expected. Groundwater wells are well protected by their distance from the polluted sites as well as by their relatively great depth. In areas not well covered by the public water supply, the local water sources have never been used as drinking water but only for other purposes. Therefore it is concluded, that the hazardous waste disposed of in Abidjan should present no risk to the drinking water quality.
- The UNDAC team debriefed the UNCT and participated in a press conference with the Humanitarian Coordination, heads of UNICEF and WHO, in order to brief national and international media about its findings. A special debriefing for the humanitarian coordinator will be done 20 September by the team leader.

## **Summary of Recommendations**

### **General**

- UN Humanitarian Coordinator to initiate dialogue with the newly-named government Focal Point in the Prime Minister's Office to keep abreast of emerging needs and potential areas for assistance
- WHO support to Ministry of Health in ascertaining veritable health impact and monitor medium- to long-term effects
- Information management during a crisis of this nature was seen to be vital and an inter-agency public information cell should ensure use of common understanding and reporting of the crisis
- For all types of emergencies, a UN inter-agency task force should immediately be set up to ensure concerted inter-agency communication strategies
- Inter-agency/government contingency plan for technological risks should be developed, including support to authorities in creation of disaster management cell for future emergencies (UNDP/BCPR & OCHA)

- In view of the excellent coordination and cooperation between the UNDAC team and the liaison officer from EC-MIC, the opportunity should be taken to strengthen the working relationship through joint lessons learned and training activities
- For similar types of UNDAC missions in the future, we would recommend inclusion of a medical expert (public health, toxicology, epidemiology) to complement the technical information and assist understanding of the medical impact of the crisis
- The inclusion of a mapping specialist and related backstopping is crucial to a crisis of this type in order to allow for proper strategies to be developed
- The delicate political context of this mission reinforced the need for a dedicated public information specialist to be included in the UNDAC team

### Mapping Recommendations

#### *Short term (next six weeks):*

- Update the GIS database on site locations, to take account of new truck sites, potentially additional contaminated waste sites, and the clean-up process
- OCHA, in collaboration with CNTIG, should maintain close links to ONPC, CIAPOL, Tredi and other relevant actors collaborating with UNDAC to ensure up-to-date common reference data for the situation
- The existing GIS database should be updated by OCHA/CNTIG using the same methodologies as applied by UNDAC in collecting site information, i.e. GPS recorders and digital photography. These updates should be undertaken together with ONPC's daily visits to contaminated sites. GIS-updates (GPS co-ordinates, photos and new maps) need to take into account new sites and changed status of known sites as clean-up work is progressing.

#### *Medium term (next three months):*

- Each site to be environmentally assessed in detail, reviewing extent of contaminated waste deposits as well as surrounding area (buildings, roads, water sources etc). This assessment should include very detailed remote sensing imagery and processing in combination with GPS recorded field verifications, photos and individual site reports.
- Waste clean-up information (type of waste, volume, post-clean-up photos) should be collected by OCHA and included in environmental GIS assessment. This assessment should utilize as recent as possible, highly detailed satellite imagery to ensure quality representation of the geographic context. The assessment could possibly be undertaken by a joint OCHA/CNTIG and UNOSAT collaborative effort.
- Results should be used to serve as a detailed record for the illegal contaminated waste dumping that has taken place. In addition, the study should be used for training and awareness-raising of national officials, including environmental officers and disaster management professionals, leading to capacity building and quality contingency plans, including the set-up of one central governmental operational emergency co-ordination centre, including representatives from all ministries and other relevant actors.

#### *Long term (next 12 months):*

- A national hazard mapping plan should be established, focusing firstly on Abidjan and Yamoussoukro using standard GIS methodologies and remote sensing (satellite) imagery. This plan should include a GIS database and up-to-date hardcopy maps and should be part of an overall national contingency plan for natural, technological and complex disasters. Again, ONPC should be involved in this activity together with experienced relevant GIS and mapping actors nationally and internationally.

## Technical Recommendations

### ***UNDAC Environmental Experts – (Report in Annex V)***

#### *Immediate precautionary measures*

- Avoid contact with any waste material or contaminated soil or water
- Keep away from identified sites
- Do not eat vegetables growing close to identified sites
- Do not eat dead animals or dead fish found close to identified sites
- While at this moment there is no information as to hazardous waste pollution of the lagoon or the possible effect on the food chain, it is advisable that any dead fish found there should not be eaten

#### *Clean-up Operation*

- To prevent further infiltration of chemical waste into the soil, the clean-up of affected areas should be commenced as quickly as possible, to include a plan of action for loading, transporting, storage, analysis and treatment of the waste (including protective safety and security measures).

#### *Monitoring*

- To enable a fuller picture of the environmental impact of the dumping of the waste, analysis and information gathering at the various sites should continue in the future, with the support of technical experts in-country.
- Monitoring of the potential secondary effects is not believed to be of paramount importance provided that the clean-up operation is performed according to the proper standards.

#### *Dumping sites*

- Location of any other possible dumping sites
- Carry out environmental assessment at each site

### ***UNDAC Hazardous Waste Expert (HWE) (Report in Annex II)***

#### *Securing the Sites*

- ONPC advised to use guards to secure the trucks containing liquid waste.
- It was recommended to mark the polluted sites with plastic strips and with warning signs (*note: now largely completed by ONPC*).

#### *Clean-up of Polluted Sites*

- Clean up of the polluted sites as soon as possible.
- Ensure application of international conventions and directives relevant to hazardous waste management
- Ensure protection of the public
- Advisability of independent monitoring of clean-up operations

#### Pollution of Ebrie Lagoon

- Sampling and analysis of water from the lagoon as a safety measure.

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## ANNEX I

### Meetings of the UNDAC Team

#### International Responders

- EC-MIC (European Commission Monitoring & Information Centre)
- French team of technical experts
- CDC (Centre for Disease Control)
- Dutch Investigative Team

#### International Community in Abidjan

- ONUCI (United Nations peacekeeping mission in Cote d'Ivoire)
- Representatives of the UN system in Abidjan
- The UN Humanitarian Coordinator a.i.
- Briefing to General Humanitarian Information meeting (UN, international, national NGOs and impartial forces)
- IAHC (Inter-Agency Humanitarian Coordination Committee)

#### National Authorities

- The Prime Minister
- The Minister of Economic Infrastructure
- Ministry of Environment
- ONPC – Office National de Protection Civile
- CIAPOL (government entity dealing with anti-pollution)
- CNTIG (Centre national de teledetection et d'information géographique - national mapping authority)

#### Private Contractor

- Tredi



## ANNEX II

### UNDAC TEAM IN COTE D'IVOIRE TOXIC WASTE CRISIS SEPTEMBER 2006

#### Report of the Hazardous Waste Expert

##### Introduction

The hazardous waste expert (HWE) joined the UNDAC team in Abidjan from 12-19 September 2006. He was immediately briefed about the situation by the team leader and the team members.

##### Situation Overview

Hazardous Petroleum Industry residue from a ship was offloaded at Abidjan. In tank trucks it was transported from the ship and desposited at 10 to 14 sites within the area of the city of Abidjan. It was deposited near roads, open water, forests and into the sewerage system and possibly the lagoon in Abidjan.

A team of technical experts from French civil protection arrived a few days before the UNDAC team and assessed the situation in considerable depth. With high standard measuring equipment the French team could reach an overall judgment of the toxicity and the remaining threat of the polluted sites.

The UNDAC team experts, as well as with the French team, agreed that the poisonous gaseous emissions had ceased since the toxic substances (H<sub>2</sub>S and mercaptans) contained in the liquid had substantially evaporated. Information on the location and content of the trucks which transported the hazardous waste could not be clarified. Only one such truck was able to be inspected by a member of the UNDAC team.

##### Securing the Sites

The Ivorian Authorities (Civil Protection) have been advised by the HWE to use guards to secure the trucks containing liquid waste. It was not clear whether the trucks contain the original hazardous liquid and sludge or liquid pumped from polluted sites.

It was recommended to mark the polluted sites with plastic strips and with warning signs. This work is already partially completed.

### **Clean-up of Polluted Sites**

Even though the immediate danger was now past, it was recommended to the Ministry of Economic Infrastructure to clean up the polluted sites as soon as possible. The Ministry invited a private French company to submit an offer which was presented during an inter-departmental high level meeting with the company at the Prime Minister's Office.

The HWE was invited to this meeting and gave a number of recommendations regarding environmental protection aspects of the issue, which were much appreciated. (Details attached.)

### **Ensuring Safe Quality of the Drinking Water**

Analysis indicates that no substance remaining in the hazardous waste would be toxic in the drinking water in the concentrations to be expected. The groundwater wells are well protected by their distance from the polluted sites as well as by the relatively great depth. In the areas not well covered by the public water supply, the local water sources have never been used as drinking water but only for other purposes. Therefore it is concluded, that due to an advantageous structure of the drinking water supply system, the risk of pollution by the hazardous waste disposed of in Abidjan should present no risk to the drinking water quality.

### **Pollution of Ebrie Lagoon**

Since it is possible, although not confirmed, that hazardous material was discharged into the Ebrie Lagoon and that diluted liquid has been running from the polluted sites into these waters, it must be considered that the water may have been polluted. The government has issued a public warning that no fish caught in the bay should be eaten. However, any pollution from the hazardous waste can be assumed to already have been strongly diluted. The pollution levels already existing in the lagoon prior to the dumping would be too high to allow for identification of the hazardous waste in question.

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Abidjan, 18 September 2006

**Meeting at the Prime Minister's Office on Clean-up of Polluted Sites  
Abidjan, 14 September 2006**

Present:

Minister of Finance,

Minister of Public Infrastructure

Delegate of the Ministry of the Environment

Lawyers

Other officials

Representatives of the private company in charge of depollution activities

Technical expert of the UNDAC team (Hazardous waste expert)

## **Introduction**

In the City of Abidjan there are 10-14 sites polluted by disposed hazardous petroleum waste. The incident was 19 and 20 August 2006. The clean-up of these sites is urgent as the rainwater is diluting and spreading the pollution.

The Government of Cote d'Ivoire has decided to immediately contract a private company with the clean-up of these polluted sites in order to get the matter settled.

## **Subjects of the Meeting**

### *The Company*

The company has submitted an offer in the form of a contract to the Ministry of Infrastructure of the Ivorian Government. The company has many years of experience in the field of international hazardous waste management.

### Discussion

A general discussion is held about the cooperation between the company and the Ivorian Government. The UNDAC expert made some recommendations concerning timing, application of international conventions and directives relevant to toxic waste management, and protection of the public as well as the advisability of independent monitoring.

### *Final Commercial Negotiations*

The UNDAC expert did not take part in the final (commercial) meeting of the Minister(s) with the private company.

Abidjan, 15.09.2006

**Meeting at the Direction de l'hydraulique humaine, Ministère d'Infrastructure Economic  
Abidjan, 18 September 2006**

**Re: Possible pollution of the drinking water of Abidjan by hazardous waste**

Present:

Director, Direction de l'hydraulique humaine

Civil Engineer, Direction de l'hydraulique humaine

Technical expert of the UNDAC team (Hazardous waste expert)

## **Geographic Location of the polluted Sites and the Wells**

HWE presented maps of polluted sites and indicated the possible value of this information for any later evaluation of groundwater pollution. According to a map of the Direction de l'hydraulique humaine, the locations of the wells will be transferred onto the digital map of UNDAC, to be later transferred into the digital system.

An overview of the map gives a clear picture, that no well is nearer than one km away from a polluted site. On average, they are at least two km away. This is a quite comfortable distance regarding pollution protection.

## **The Drinking Water Supply System of the City of Abidjan**

The public drinking water supply system of the City of Abidjan consists of 8 main groundwater wells and the distribution system. There are areas not completely covered by the distribution network. The population in these areas may have their own wells or sources of surface water. However, they never use this water as drinking water; they use it for irrigation, cleaning and for toilet flushing. In these areas, they buy drinking water in bottles.

The wells are 60 to 100m deep. A study has been made on the permeability of the ground in the area of the wells and it has been found that the percolation time of surface water to the groundwater level is in the range of two years.

## **Hazardous Waste Pollution**

The hazardous waste has been analysed by the Dutch Forensic Institute from a sample taken at the time the ship was in the harbour of Amsterdam, before it departed for Cote d'Ivoire. A copy of the analysis has been handed over to the Director of the Direction de l'hydraulique humaine. Information on the phenol concentration has still not been received and should be transmitted to him as soon as known. The composition of the waste was discussed and it was found that only the aromats, such as the phenols, as well as the mercaptans, might have a very small potential to have a dangerous effect on the drinking water quality.

## Remaining Risks

The Director is still concerned about surface water flow from polluted sites to areas of groundwater wells. The UNDAC member informed him about the cleaning up of the polluted sites by the private company which started today and will be completed in 6 weeks.

## Conclusions

The above analysis indicates that no substance remaining in the hazardous waste would be toxic in the drinking water in the concentrations to be expected.

The groundwater wells are well protected by their distance from the polluted sites as well as by the relatively great depth. In the areas not well covered by the public water supply, the local water sources have never been used as drinking water but only for other purposes.

Therefore it is concluded, that due to an advantageous structure of the drinking water supply system, the risk of pollution by the hazardous waste disposed of in Abidjan should present no risk to the drinking water quality.

Abidjan, 18.09.2006

UNDAC team

### ANNEX III

## **Geographic Information System (GIS) and mapping in support of co-ordination of contaminated waste assessments and clean-up in Abidjan, Cote d'Ivoire**

### **Activities of the UNDAC team mapping expert**

The UNDAC team liaised with relevant GIS and mapping entities in Abidjan, including OCHA, Centre National de Teledetection et Information Geographique (CNTIG), and UNOCI GIS Unit. To support the UNDAC mission, UNOSAT has provided maps produced in Geneva. Up-to-date maps were hardcopy printed by OCHA and CNTIG.

On 12 September, an UNDAC team member participated in a collaborative field assessment to all known contaminated waste sites. This assessment included representatives from the Office National de Protection Civile (ONPC), CIAPOL (national entity dealing with pollution issues), Protection Civile Francaise, European Commission Monitoring Information Centre (EC-MIC) and UNDAC. The assessment included Global Positioning System (GPS) recording of exact locations of contaminated waste sites, digital photography recording of each site, estimated dimensions of directly affected areas and overall state of contaminated waste at the sites. As new sites became known, these were documented (GPS and photographs) during the following days.

Parameters recorded in the assessment were shared with relevant GIS actors to promote a common baseline dataset to be used by national institutes as well as UN and NGO organizations. This has resulted in common map references used by national organizations and the humanitarian community in Abidjan.

UNDAC and OCHA has linked CNTIG with ONPC to kick-start a process of close interaction and sharing of information in order to prepare all relevant actors for updated global GIS database for identified sites.

Up-to-date maps, list of contaminated sites including GPS co-ordinates and photos were shared with the private company (Tredi) selected for the waste clean-up on 16 September. This enabled the company to begin detailed planning of the clean up process and was highly appreciated.

### **Recommended plan of action**

#### *Short term (coming six weeks):*

It is important to update the GIS database on site locations since this may evolve with the discoveries of new truck sites, potentially additional contaminated waste sites, and the clean-up process to be launched on Sunday 17 September. It is therefore recommended that OCHA, in collaboration with CNTIG, maintain close links to ONPC, CIAPOL, Tredi and other relevant actors collaborating with UNDAC in order to ensure up-to-date common reference data for the situation. The existing GIS database should be updated by OCHA/CNTIG using the same methodologies as applied by UNDAC in collecting site information, i.e. GPS recorders and digital photography. These updates should be undertaken together with ONPC's daily visits to contaminated sites. GIS-updates (GPS co-ordinates, photos and new maps) need to take into account new sites and changed status of known sites as clean-up work is progressing.

*Medium term (coming three months):*

Secondly, each site needs to be environmentally assessed in detail, reviewing the extent of contaminated waste deposits as well as surrounding area (buildings, roads, water sources etc). This assessment should include very detailed remote sensing imagery and processing in combination with GPS recorded field verifications, photos and individual site reports. Waste clean-up information (type of waste, volume, post-clean-up photos) should be collected by OCHA and included in environmental GIS assessment. This assessment should utilize as recent as possible, highly detailed satellite imagery to ensure quality representation of the geographic context. The assessment could possibly be undertaken by a joint OCHA/CNTIG and UNOSAT collaborative effort. The results should be used to serve as a detailed record for the illegal contaminated waste dumping that has taken place. In addition, the study should be used for training and awareness-raising of national officials, including environmental officers and disaster management professionals, leading to capacity building and quality contingency plans, including the set-up of one central governmental operational emergency co-ordination centre, including representatives from all ministries and other relevant actors.

*Long term (coming 12 months):*

Thirdly, it is further recommended that a national hazard mapping plan is established, focusing firstly on Abidjan and Yamoussoukro using standard GIS methodologies and remote sensing (satellite) imagery. This plan should include a GIS database and up-to-date hardcopy maps and should be part of an overall national contingency plan for natural, technological and complex disasters. Again, ONPC should be involved in this activity together with experienced relevant GIS and mapping actors nationally and internationally.

UNDAC

Abidjan, 16 September 2006

## ANNEX VI MAPS OF CONTAMINATED SITES IN ABIDJAN



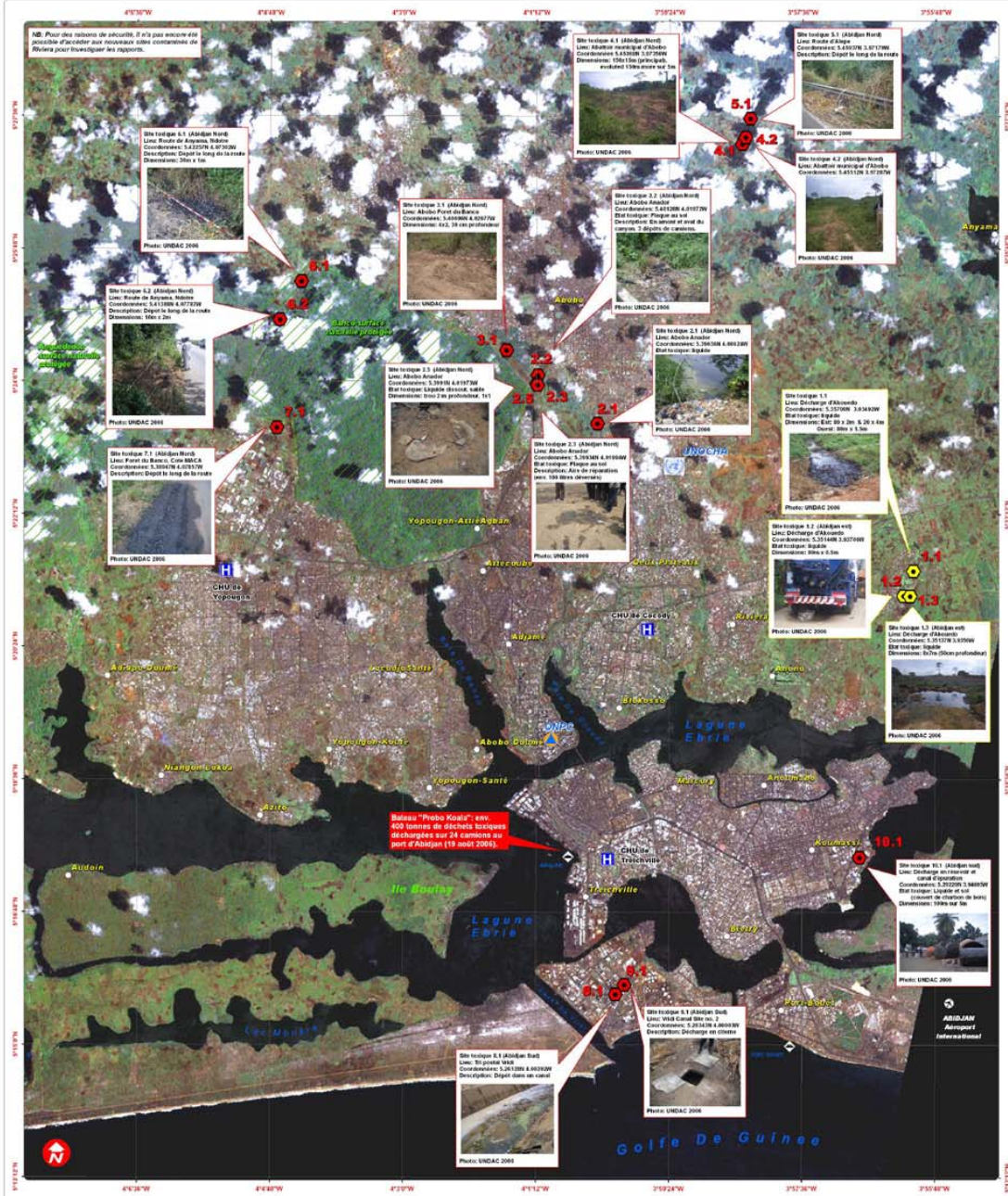
Prepared by CNTIG in collaboration with the government of CDI, CIAPOL, ONPC (Office National de Protection Civile), European Union, French Civil Protection, and OCHA. Site locations and photos by UNDAC.



# Abidjan: Carte des sites contaminés

Emplacements des sites de déchets toxiques documentés par l'équipe de terrain UNDAC du 12 au 17 septembre 2006

V1.3  
Mise à jour:  
18 septembre 2006



**Legende**

- Site contaminé
- Site non contaminé
- Site suspect
- Site en cours de décontamination
- Site en cours de réhabilitation
- Site en cours de fermeture
- Site en cours de destruction
- Site en cours de transfert
- Site en cours de traitement
- Site en cours de stockage
- Site en cours de recyclage
- Site en cours de valorisation
- Site en cours de réutilisation
- Site en cours de réhabilitation
- Site en cours de fermeture
- Site en cours de destruction
- Site en cours de transfert
- Site en cours de traitement
- Site en cours de stockage
- Site en cours de recyclage
- Site en cours de valorisation
- Site en cours de réutilisation

**Scale of the map:** 1:47500 (for A4 paper) / 1:95000 (for A3 paper)

**Scale bar:** 0 500 1000 2000 3000 4000 Mètres

**Map Information:** La représentation de l'Abidjan sur cette carte est basée sur les données de l'IGN (Institut National de la Géographie et de l'Aviation Spatiale) et de l'UNEP (United Nations Environment Programme). Les données de l'IGN sont à jour au 31/12/2005. Les données de l'UNEP sont à jour au 31/12/2005. Les données de l'UNEP sont à jour au 31/12/2005. Les données de l'UNEP sont à jour au 31/12/2005.

**Carte réalisée en collaboration avec:** Gouvernement de Cote d'Ivoire, CIAPOL, ONPC, Union Européenne, Sécurité Civile France, UR/OCHA

**UNOSAT**  
satellite imagery for all

Prepared by UNOSAT in collaboration with the government of CDI, CIAPOL, ONPC (Office National de Protection Civile), European Union, French Civil Protection, and OCHA. Site locations and photos by UNDAC.

**ANNEX V**

**UNDAC TEAM IN COTE D'IVOIRE  
URBAN HAZARDOUS WASTE DUMPING  
SEPTEMBER 2006**

**Technical Report of Environmental Experts on UNDAC Team**

**Introduction**

It should be noted that the experts of the UNDAC team were tasked to perform an indicative environmental assessment of the impact of the hazardous waste dumping to enable fast decision-making processes during a crisis situation. Account has been taken of the prevalent environmental conditions existing in Abidjan prior to the dumping and, whilst not claiming to be fully extensive, it consists of an expert judgment based on available and reliable data.

**Conclusions of environmental impact assessment**

The main chemicals found in the original waste are hydrogen sulphide (H<sub>2</sub>S), mercaptans, phenols, hydrocarbons (a mixture of paraffins, olefins, naphthenes and aromatics). These chemicals can be harmful to humans and the environment if serious exposure takes place.

It is likely that evaporation of volatile substances could have occurred in the direct aftermath of the dumping, possibly resulting in serious or even life-threatening concentrations, however it is not known how many people were directly exposed.

It is believed that three weeks after the dumping of the waste the concentrations of the concerned compounds in the air are low and no further adverse health effects are to be expected. However the chemicals, especially mercaptans have strong smells at low concentrations. The smell is already detectable by the human nose at concentrations far below danger levels. This may give a false impression of toxicity.

Provided the clean-up operations are carried out in accordance with accepted technical standards, no further impact on health or the environment should be expected.

**Environmental impact assessment**

The overall objective of the environmental assessment of the current situation is to provide an indication of the hazards to the population and the impact on the environment. The impact of the current situation can best be estimated by reviewing the possible hazard (defined by the characteristics and toxicity of substances present), the quantity and the exposure of the main receptors as shown below:

$$\text{IMPACT} = \text{HAZARD} \times \text{QUANTITY} \times \text{EXPOSURE}$$

The main receptors for which the hazard, quantity and exposure need to be evaluated are:

1. the population that is potentially exposed to the hazardous waste (including the evaporated substances) and
2. the local environment (e.g. drinking water sources, food chain, aquatic environment).

The general impact assessment is made for two different timeframes:

1. the situation directly following the dumping and
2. the situation as it appeared during the presence of the UNDAC team in Cote d'Ivoire.

## Dumping sites

1. As of 13 September, 10-14 dumping sites had been reported, however the true number has yet to be confirmed. Of the originally-reported 11 sites, 8 were confirmed by the French team of experts. Four missing trucks used to transport the waste are also being called "sites", but have not yet been located and may have left the city. Some identified sites had been cordoned off and warning signs posted.
2. It is alleged that about 500 tons of waste has been dumped but it is difficult to confirm this quantity.
3. On the night of 14-15 September, it was reported that more illegal dumping of the same hazardous waste took place. The locations, extent and amount of these dumpings are not yet known, nor the probable effects.
4. The characteristics of the sites are very different in size and nature. For example one is beside the municipal waste site (Akouedo), others are alongside roads, one is close by open sewage systems or natural rain channels. Due to slope and/or heavy rainfall, it is possible that the dumped waste may spread by means of these water channels which can overflow into the lagoon during periods of heavy rain. Some sites consist of liquid waste; at others the waste has already infiltrated into the ground.
5. In an attempt to reduce the smell of the hazardous waste, ONPC covered some with charcoal.
6. The site at Akouedo is possibly the most seriously contaminated. The dumping here took place beside an existing landfill for municipal waste.

## Hazard: nature of the hazardous waste

7. The chemical composition of the waste found at the sites is comparable to samples taken from 'Probo Koala' prior to the vessel's departure from Amsterdam, where it had previously docked. The results of analysis of waste samples taken in Abidjan and Amsterdam indicate that it is petrochemical waste.
8. The main chemicals found in the samples are hydrogen sulphide (H<sub>2</sub>S), mercaptans, phenols, hydrocarbons (a mixture of paraffins, olefins, naphthenes and aromatics). Only trace amounts of chlorinated hydrocarbons were found (insignificant levels). These chemicals can be harmful to humans and the environment if serious exposure takes place.
9. The chemicals, especially mercaptans and hydrogen sulphide, have strong smells at low concentrations. The smell is already detectable by the human nose at concentrations far below danger levels. This may give a false impression of toxicity.

## Exposure

The main forms of direct exposure would be through inhaling the volatile substances and through skin contact. Secondary exposure could occur in the medium- to long-term through contact with ground and surface water or through accumulation in the food chain (e.g. crops, fish). Hydrogen sulphide and mercaptans are the most volatile and are easily dispersed by air. Most substances of concern are mobile in soil.

### **Exposure immediately following dumping**

10. No readings or measurements were taken at the time of the dumping, so there is no information available on direct exposure in the immediate aftermath. It is likely that evaporation of volatile substances could have occurred, possibly resulting in serious or even life-threatening concentrations.
11. On the basis of the data available at this time, it is not possible to assess if and over what distance/area life-threatening concentrations of these substances may have been present and if and how many people may have been exposed.
12. In the immediate aftermath of the dumping, the issue of secondary exposure is not relevant.

### **Direct exposure as at the arrival of the UNDAC team**

13. At the time of UNDAC team visits to sites believed to have the highest potential risk, direct exposure by inhalation was unlikely given the time lapse (over three weeks), the measures already taken and dilution since the dumping. This was confirmed by the air sampling and analysis carried out by the French Civil Protection team. None of the components were found in substantial concentrations in the ambient air close to the waste.

### **Secondary exposure as at the arrival of the UNDAC team**

The possibility of secondary exposure through contact with surface water, groundwater and the food chain (vegetation, crops, fish) has been considered.

14. From the site visits, short-term secondary health effects would not appear to pose any additional problems provided there is no direct contact with the waste. In the Akouedo area, vegetables are grown nearby dumping sites on existing municipal waste areas. The hazardous waste is not believed to have had any contact with these plants and thus has not compounded the pre-dumping situation. In Akouedo, irrigation water is fetched from a channel near to the contaminated areas which could, after periods of heavy rain, cause slight contamination from the waste. Nevertheless, the Ivorian Civil Protection plan to destroy the plants situated in the vicinity as a precaution and general measure to discourage the practice of planting vegetables on waste.
15. Whilst not discarding the possibility that hazardous waste may have entered the lagoon, there was no indication of its presence. In any case of contamination of the lagoon, dilution will have occurred.
16. The spreading of hazardous components in the soil and groundwater depends, for example, on the hydrological characteristics of the soil and groundwater flow. Potential for depth of infiltration through the soil and dispersion by groundwater has been estimated by the French experts to be about 10 meters. This estimation is believed by the UNDAC team to be approximate and highly dependent on the local soil conditions.

UNDAC team, Abidjan  
18 September 2006

*FRENCH TRANSLATION OF FINDINGS AS AT 13 SEPTEMBER 2006*

**Impacts environnemental et sanitaire résultant du déversement des déchets à Abidjan**

Basés sur des informations collectées par l'équipe UNDAC à la date du 13 septembre

**Sites de déversement**

- 10 à 14 sites de déversement ont été rapportés. Cependant, le vrai nombre de sites n'est pas encore confirmé. Initialement, 11 points ont été indiqués, dont 8 confirmés. L'équipe d'experts français n'a pas pu confirmer 3 points. 4 camions utilisés pour le transport des déchets sont également appelés des sites mais ne sont pas encore localisés et auraient peut être quitté la ville.
- Les sites identifiés ont été visités les équipes de la protection civile, les experts de CIAPOL, UNDAC, ECHO/MIC et la protection civile française.
- Les caractéristiques des sites sont différentes du point de vue de la taille et de la nature. Par exemple, un site est à coté du principal site municipal de déchets, les autres sont au long des routes, un est sur une chaîne menant à un lac et d'autres par terre.
- Les autorités mènent des efforts pour compiler un inventaire complet des différents sites de déversement.
- A ce stade, il n'y a pas d'information fiable concernant le matériel de déversement direct de déchets dans la lagune Ebrié.
- Des populations vivent aux alentours de quelques sites. Dans certains cas, il y a des jardins potagers.
- La majorité des sites ont été balisés

**Composition des déchets toxiques**

- La composition chimique des déchets trouvés dans les sites est comparable aux résultats de l'analyse des échantillons de déchets relevés et analysés à Amsterdam avant leur expédition en Côte d'Ivoire -connus pour être des déchets pétrochimiques.
- Les principaux groupes chimiques préoccupants sont le sulfure hydrogène, le mercaptan, le phénol, les hydrocarbures (un mélange de paraffines, oléfines, naphéne et aromatique). Des hydrocarbures chlorés ont été seulement trouvés en trace. Ces composantes peuvent être nocives à l'environnement et aux êtres humains.

**Effets directs**

Les effets dépendent des caractéristiques de la substance et de l'exposition. Bien que les déchets contiennent des substances toxiques l'exposition est à prendre en considération pour tout effet nocif encouru. Une exposition directe est possible à travers un contact avec la peau et l'inhalation des substances volatiles.

- En ce moment, l'exposition directe par inhalation est peu probable, vu le temps écoulé depuis le déversement. Ceci a été confirmé par l'échantillon d'air analysé par l'équipe de la protection civile française. Aucune des composantes n'a été trouvée en concentration substantielle dans l'air ambiant proche des déchets.
- Les composantes concernées, spécialement le mercaptan et le phénol, ont une forte odeur à faible concentration. L'odeur est déjà détectée par le nez à des niveaux de concentration en deçà du danger. Ceci peut conduire à une fausse impression de toxicité.
- Il n'y avait pas de mesures prises au moment des déversements, ainsi il n'y a pas d'information disponible sur l'exposition directe des suites immédiates mais il est probable que l'évaporation des substances volatiles aient probablement causé des effets sanitaires contraires.

### **Risques d'exposition**

Les risques d'exposition sont possibles à travers le contact avec l'eau à la surface, la terre et probablement la nourriture (végétation, récolte, poisson).

- Le potentiel d'infiltration serait possible à travers la terre et la dispersion de l'eau a été estimée par les experts français à une profondeur bien supérieure aux adductions d'eau. La qualité de l'eau est contrôlée trois fois par jour.
- Les risques d'exposition à travers la végétation près des sites de déversement sont actuellement estimés faibles.
- Aucune évidence n'a été trouvée pour lier la présence de poissons morts dans la lagune au déversement des déchets toxiques.

### **Impact sur la santé**

- Pendant que plusieurs milliers de personnes ont bénéficié des consultations médicales gratuites disponibles à la suite du déversement des déchets toxiques, le nombre de personnes effectivement affectées n'est pas encore possible à établir.
- Comme mesures de précaution
  - Eviter le contact avec les déchets, la terre ou l'eau contaminées
  - Se tenir loin des sites identifiés, au moins 100 mètres
  - La végétation qui pousse près des sites ne doit pas être consommée
  - Les animaux morts ou les poissons morts trouvés près des sites identifiés ne doivent pas être consommés

### **Opérations de suivi**

- Pour permettre une image complète de l'impact environnemental du déversement des déchets toxiques, l'analyse et l'information collectée dans les divers sites doivent continuer dans les jours à venir, avec l'appui des experts techniques dans le pays
- Pour prévenir plus d'infiltration des déchets chimiques dans la terre, le nettoyage des zones affectées doit commencer le plus rapidement possible et inclure un plan d'action pour le chargement, le transport, le stockage, l'analyse, le traitement des déchets aussi bien que le suivi de la qualité de l'air et d'autres mesures de sécurité durant l'opération de nettoyage.