SITE 8: AGBOVILLE

ENVIRONMENTAL AUDIT OF THE SITES IMPACTED BY THE "PROBO KOALA" TOXIC WASTE DUMPING IN ABIDJAN, CÔTE D'IVOIRE

This series of fact sheets was prepared as part of UN Environment's environmental audit of the sites impacted by the "Probo Koala" toxic waste dumping in Abidjan, Côte d'Ivoire. The fact sheets provide complete analysis results, observations and the recommendations for each of the sampling sites. They should be read in conjunction with the full assessment report, available at: www.unep.org/CotedIvoire

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Site Description

Site name: Agboville
UN Environment site reference no: 8

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Spill History

This site, located within the municipality of Agboville, some 61 km north of Abidjan, is not a dumping location. Rather, Site 8 has been used to treat a stockpile of dry maize that was suspected to have been contaminated through airborne pollution following the 2006 dumping event in the Vridi area. This maize was moved here in 2012 from the Treichville silos it was stored in for several years after the dumping.

A contract for removal, transport and treatment of the maize was signed by the Government and a company named Envipur in November 2010, and the work started in January of 2012. Site 8 was originally a remote green-field site, selected and purchased by Envipur for its considerable distance from Abidjan. The maize was placed in a single cell constructed on the site, the base of which was lined with a geo-membrane. All drainage from the treatment cell is contained within concrete chambers, from where it is periodically pumped and placed in plastic tanks that are transported back to Abidjan for treatment. As part of its contracted services, Envipur has conducted periodic sampling and analysis of the composting maize itself, the leachate draining from the pile, as well as the small river running downstream, beyond the treatment site.

Once composting of the maize was deemed to have sufficiently progressed, the material was covered with a 1 m thick layer of soil dug up from around the treatment cell. By end 2016, treatment was declared to be nearing completion, and at of the time of writing, a draft closure report was available from Envipur, and was awaiting approval from the Government.

Throughout the treatment and at the time of UN Environment's last site visit in January 2017, the site was fenced and guarded, restricting access to the public and grazing animals.

Approach

UN Environment conducted two rounds of sampling on this site, the first in July 2016 and the second in January 2017. The following soil/composted maize samples were taken during the initial exercise in July 2016:

- A composite surface sample (0-20 cm) and 1 m-depth sample were obtained from the top of the mound of composted maize, which was covered by approximately 1 m of soil; and
- At the lower level of the site, approximately 100 m away from the composted maize, two further soil samples were taken, one from the surface (0-20 cm) and one at 1 m in depth.

As the analyses conducted on the July 2016 samples included at least one result that exceeded the standard used by Envipur for heavy metal contamination, an additional round of sampling was undertaken in January 2017, consisting of the following samples:

- One 1 m-depth soil sample from the centre of the composting cell;
- One shallow composite soil sample (0-20 cm) from across the surface of the composting cell; and
- One shallow composite soil sample (0-20 cm) further down the slope near the guard's shack.

In addition, during both rounds of sampling, water samples were taken from a manhole connected to the concrete chambers collecting leachate from below the composting maize pile. During the first round, an additional surface water sample was also taken from the river downstream, as there was no groundwater source nearby. Finally, an air sample and two samples of comestible vegetation (cassava) were collected from the site.

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Assessment Criteria

Based on the different analyses of the chemical composition of the samples taken onboard the Probo Koala in 2006, as well as those undertaken on samples collected on the dumping sites, UN Environment considered the following groups as the key contaminants of interest for the audit:

- Petroleum hydrocarbons;
- Sulfur compounds; and
- Heavy metals.

The speciation of contaminants to be analyzed within the above three groups was primarily determined by what was present in the Probo Koala waste as well as the environmental standards set by the Government of Côte d'Ivoire for clean-up. In addition, the impact of high levels of sodium hydroxide was measured through the pH value of the soil.

In the case of Site 8, where maize that had been potentially contaminated by the Probo Koala wastes was composted, and for which the Government did not provide clean-up standards, laboratory results for **soil** were compared against French standard NF U 44-095 for trace metal elements in composted materials used as fertilizer, which the contractor, Envipur, is using to evaluate the status of the maize pile. It should be noted that as the Government did not include hydrocarbons in the parameters requiring monitoring as part of the maize composting process, no comparison of the hydrocarbon values obtained has been made to locally set standards or international guidelines.

If laboratory results for a given parameter showed values exceeding the clean-up standards set by the contractor, results were then compared with the internationally recognized Dutch soil remediation standards (intervention values) to see if further immediate action was needed from an environmental point of view. Dutch standards have been in existence for over 30 years and are used as a basis for contaminated site assessment and clean-up in many parts of the world, when local standards are not available.

For **air** quality analysis, for which no national standards exist in Côte d'Ivoire, the approach taken was to compare air quality results from the affected sites with Control Site 21 nearby.

In the absence of national standards for water quality, results for **groundwater** (leachate) quality were compared against Dutch intervention values. It was not possible to compare **surface water** results, however, as Côte d'Ivoire does not have a national standard for surface water quality, and surface water was not sampled at any of the control sites.

Fruit and vegetable samples were tested using similar protocols as those used for analysis of soil and water samples. In the absence of national food quality standards, the European Commission's maximum levels of certain contaminants in food stuffs (EC regulation 1881/2006) are used for comparison. It should be noted that as it was found that there were interferences from naturally occurring substances with the hydrocarbon analyses, the analytical results relating to hydrocarbons were discarded.

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Laboratory Analysis Findings

Soil 2016 Parameters (mg/kg)	Site 8 Agboville				French norm NF U 44-095 (mg/kg)	Dutch intervention values (mg/kg)
	0-20 cm	1 m	0-20 cm	1 m		
Total Hy C5-C44	10.3	1,440	4.41	2.01		5,000
Benzene	< 0.009	< 0.009	< 0.009	< 0.009		1.1
Ethylbenzene	< 0.003	0.41	< 0.003	< 0.003		110
Toluene	< 0.002	1.61	< 0.002	< 0.002		32
Xylene	< 0.009	< 0.009	< 0.009	< 0.009		17
Total sulfur (%)	< 0.02	0.027	< 0.02	0.0786		-
Pb	13	11	11	15	180	530
Cd	0.10	< 0.1	< 0.1	< 0.1	3	13
As	3.4	2.5	1.8	2.8	18	76
Cr	340	270	150	100	120	180
Ni	6.6	7.2	5.4	11	60	100
Co	1.3	1.1	1.1	2		190
Hg	0.054	0.052	0.04	0.071	2	36
Cu	12	11	7.7	6.5	300	190
Zn	28	35	13	26	600	720
pH	4.38	4.58	4.72	3.83		

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Soil 2017 Parameters (mg/kg)	Site 8 Agboville			French norm NF U 44-095 (mg/kg)	Dutch intervention values (mg/kg)
	1 m	0-20 cm	0-20 cm		
Total Hy C5-C44	2,230	3.83	13.4		5,000
Benzene	< 0.09	< 0.009	< 0.009		1.1
Ethylbenzene	< 0.04	< 0.004	< 0.004		110
Toluene	2.6	< 0.007	< 0.007		32
Xylene	< 0.2	< 0.02	< 0.02		17
Total sulfur (%)	0.119	0.054	0.0641		-
Pb	9.98	13	12.5	180	530
Cd	< 0.02	0.514	< 0.02	3	13
As	2.82	< 6	3.56	18	76
Cr	237	243	254	120	180
Ni	5.31	5.47	5	60	100
Co	0.605	< 1	0.222		190
Hg	< 0.14	< 1.4	< 0.14	2	36
Cu	6.66	< 14	8.05	300	190
Zn	16.9	< 19	5.39	600	720

Fruit and vegetable	Site 8 Agboville		Control site 21 Agboville	EC regulation (mg/kg)
Parameters (mg/kg)	Cassava	Cassava	Pomegranate	
Total sulfur (%)	< 0.02	0.0408	0.0547	
PAH	< 0.118	< 0.118	< 0.118	
Pb	< 0.7	< 0.7	< 0.7	0.1
Cd	< 0.02	< 0.02	< 0.02	0.1
As	< 0.6	< 0.6	< 0.6	
Cr	< 0.9	< 0.9	1.62	
Ni	1.65	0.406	0.82	
Co	< 0.1	< 0.1	0.149	
Hg	< 0.14	< 0.14	< 0.14	
Cu	3.04	2.07	3.85	
Zn	6.98	12.4	22.9	

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Groundwater Parameters (µg/l)	Site 8 Agboville 2016	Site 8 Agboville 2017	Dutch intervention values (µg/l)
Total Hy C5-35	4,470	355	600,000
Benzene	< 7	< 7	30
Ethylbenzene	192	< 5	1,000
Toluene	113	210	150
Xylene	< 11	< 11	70
Free sulfur	< 50	< 50	-
Pb	4.5	0.597	75
Cd	< 0.25	0.135	6
As	12	6.96	60
Cr	130	88.1	30
Ni	42	24.5	75
Co	10	5.62	100
Hg	5	< 0.01	0.3
Cu	5.6	3.41	75
Zn	150	35.4	800

Surface water Parameters (µg/l)	Site 8 Agboville Rivulet
Total Hy C5-35	21
Benzene	< 7
Ethylbenzene	< 5
Toluene	< 4
Xylene	< 11
Free sulfur	< 50
Pb	0.36
Cd	< 0.25
As	0.39
Cr	3.3
Ni	3
Co	3.9
Hg	0.62
Cu	1.1
Zn	3.4

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Air Parameters/units		Site 8 Agboville	Control site 21 Agboville
Dimethyl sulfide	ppm v/v	< 0.1	< 0.1
Ethyl mercaptan	ppm v/v	< 0.1	< 0.1
Methyl ethyl sulfide	ppm v/v	< 0.1	< 0.1
Carbonyl sulfide	ppm v/v	< 0.1	< 0.1
Tertiary butyl mercaptan	ppm v/v	< 0.1	< 0.1
Hydrogen sulfide	ppm v/v	< 0.1	< 0.1
Methyl tert-butyl ether	µg/m3	ND	ND
Benzene	µg/m3	ND	ND
Toluene	µg/m3	ND	ND
Ethylbenzene	µg/m3	ND	ND
Xylene	µg/m3	ND	ND
Naphthalene	µg/m3	ND	ND
TPH (C4-C6)	µg/m3	ND	10
TPH (C6-C8)	µg/m3	11	20
TPH (C8-C10)	µg/m3	23	35
TPH (C10-C12)	µg/m3	41	53
TPH (C4-C12)	µg/m3	33	120
Aliphatic (C4-C6)	µg/m3	110	ND
Aliphatic (C6-C8)	µg/m3	ND	17
Aliphatic (C8-C10)	µg/m3	21	31
Aliphatic (C10-C12)	µg/m3	21	53
Aromatic (EC5-EC7)	µg/m3	32	ND
Aromatic (EC7-EC8)	µg/m3	ND	ND
Aromatic (EC8-EC10)	µg/m3	ND	ND
Aromatic (EC10-EC12)	µg/m3	21	ND

Conclusions and Recommendations

The results from both rounds of soil sampling show levels of chromium that exceed the standards used by Envipur. Chromium, depending on its oxidation state, can be very toxic. The chromium values in the maize pile also consistently exceed Dutch intervention values. Moreover, higher chromium levels were also found in soil samples taken further away from the composting pile.

Moreover, chromium concentrations exceed Dutch intervention values in both the 2016 and the 2017 water samples collected from the manhole adjacent to the composting pile. Toluene levels are also marginally above intervention values, but as the overall hydrocarbon levels are far below, this single result cannot be considered to warrant intervention.

Surface water quality results (from the sample taken from the rivulet downstream) do not indicate high levels of hydrocarbons, nor significant heavy metal pollution.

The presence of chromium within the compost pile exceeding the standards used by Envipur as well as Dutch intervention values is a matter of concern. As the composting process will not lead to a reduction in chromium concentrations, continued composting is not a solution for this issue. As the site is currently under the custody of Envipur and monitored by the Government, further risk assessment should be carried out based on a "source-pathway-receptor" approach to see what additional actions need to be undertaken before the site can be closed.

Given that leachate samples also showed higher levels of chromium in both 2016 and 2017, as well as elevated levels of toluene in 2017, the leachate from this site should continue to be disposed of in specialized facilities, ensuring that these have appropriate technical capacity to handle this type of pollution.

The results of the air quality analysis can be summarized as follows:

- Mercaptans, hydrogen sulfide and related components cannot be detected in this site, nor the control site. This is significant considering that the key odorants in the Probo Koala wastes were most likely hydrogen sulfide and mercaptans.

- Concentrations of the various analytes at the affected site are comparable to the concentrations found at the control site.

Based on the fruit and vegetable results, the following observations can be made:

- All samples, including the pomegranate sample from Control Site 21 at Agboville, show the presence of various analytes and heavy metals. Fruits and vegetables naturally accumulate heavy metals from the soil. As most of the heavy metals are essential to human health in small quantities, their uptake through fruits and vegetables is not considered to be a risk.

- The EC standard for lead is below the detection limit of the laboratory analyses. However, considering that all samples, including control samples, show comparable heavy metal values, these results are not considered to warrant further follow up.

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Site Photos

Source: UN Environment

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