OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

FAIR USE POLICY

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

Report on Phase-2 of Pilot Demonstration Project on cleaning-up of Contaminated Sites- PPO-Tengeru Site; Tengeru, Tanzania; July 31- August 20, 2014

Prepared by: Nouri Abdalla
Regional Coordinator for SADC Sub-Region

Date: October 9, 2014

Table of Contents

Introduction 2
Objective and Expected Outcomes of Phase-2 2
1. Proceedings of Phase-2 3
1.1 Clearing the Site & Conducting Site Survey- July 31-August 2, 2014 3
1.2 Preliminary Site Investigation- Stage 2 (PSI-S2) - August 4-5, 2014 5
1.3 A visit to NHC-Morogoro Site- August 8, 2014 7
1.4 Detailed Site Investigation (DSI)- August 12-15, 2014 8
1.5 Pilot Project Team (PPT) meeting- August 15 & August 17, 2014 9
2. General Observations 9
3. Conclusion and Recommendations 10
Annexes 12
Annex No. 1: Tasks for Mission 2 Site Investigation Reporting 12
Annex No. 2: List of participants of Phase-2 of the Pilot Demo Project 15

Introduction

Following the Regional Training workshop on Assessment and Remediation of Contaminated Sites which was held in Addis Ababa, Ethiopia during the period of August 6-8, 2012, a questionnaire was sent out to all COMESA and SADC countries to be filled out to help selecting a country to host a pilot demonstration project for remediation of contaminated sites using phytoremediation technology. Six countries from both COMESA and SADC sub-regions submitted a filled out questionnaire. Based on the answers submitted by the six countries, Sudan and Tanzania emerged as the most suitable countries to host the aforementioned pilot project, with Tanzania having a slight edge over Sudan, as Tanzania seems to have experts in the area of phytoremediation, which is a great asset to have for the implementation of the pilot project.

UNIDO then decided to conduct the pilot demonstration project on remediation of contaminated site in Tanzania. Two sites were selected in Tanzania by the VP's Office-Division of Environment as potential sites to host the pilot demonstration project. These two sites are: PPO- Tengeru Site which is suspected to have been contaminated with Hexachlorocyclohexane (HCH) and Gamma HCH "Lindane", and NHC- Morogoro Site which is suspected to have been contaminated with DDT.

In December, 2013, a UNIDO team accompanied by representatives from the VP's Office-Division of Environment visited the two sites. After the conclusion of the visits to the two sites, UNIDO selected PPO- Tengeru Site to host the pilot demonstration project on cleaning up of contaminated sites.

After holding the training workshop on contaminated sites investigation and remediation for experts from Tanzania in Tengeru, Tanzania at Lake Duluti Serena Hotel, Tengeru during the period of May 13-15, 2014, Phase-2 of the Pilot Demo Project at PPO-Tengeru site was held during the period of July 30 to August 20, 2014. Phase-2 of the pilot project includes Preliminary Site Investigation-Stage- PSI-S2 (surface sampling) and Detailed Site Investigation (DSI) of the site.

Objective and Expected Outcomes of Phase-2

The principal objective of Phase-2 was to train the national experts who participated in the training workshop which held in May, 2014 (*see Annex No. 2 for List of Participants*) on the practical aspects of investigation and management of contaminated sites. Such training includes how to conduct PSI-S2 and DSI so as to determine the extent of the contamination of the site and recommend the appropriate or suitable remediation technologies to be applied.

1. Proceedings of Phase-2

1.1 Clearing the Site & Conducting Site Survey- July 31-August 2, 2014

The PPO-Tengeru contaminated site was used as a parking area for old and obsolete vehicles and trucks which belong to the Ministry of Agriculture, PPO-Tengeru and Livestock Training Institute. All vehicles and other objects were needed to be removed to clear and prepare the site for Phase-2 of the pilot demo project. A tractor from the Ministry of Agriculture was brought to the site to help with the clearing of the site. All old vehicles and other objects were removed from the site that day (July 31, 2014).

Clearing the site using a tractor

The site cleared from all vehicles- July 31, 2014

The site survey using survey equipment was conducted on August 1 and 2, 2014. Survey equipment used were: Survey measuring tapes (KESON® 1/2"W Freewheeling Fiberglass Tape Measures; GPS/GNSS systems; Picks/pins, Level (hand level, e.g. CST/Berger® Topographic Abney Level) and Leveling rod. The purpose of conducting such site survey was to learn more about the different elevations of the site, and subsequently determine the direction of the flow of the surface and/or the ground water.

Gridlines were drawn based on the main Office Building at PPO-Tengeru and the Store House up to the New Storage Building. According to the PSI-S1, which was conducted in June, 2014 by the Project Technical Assistant (PTA), the hotspot of contaminated sites is located a short distance from the Old Storage Building and the main Office Building. Coordinates for specific points in the sites were selected based on PSI-S1 and the land survey conducted on August 1 and 2, 2014.

Site survey using topographic Abney level

1.2 Preliminary Site Investigation- Stage 2 (PSI-S2) - August 4-5, 2014

On August 4-5, 2014, surface sampling using a hand auger was taken from twenty nine points in the site for chemical and physical properties analysis. The maximum depth used to collect the surface sampling was 20cm. Additionally, four surface samples were taken from the maize field which is adjacent to the contaminated site as well as two more samples were taken for chemical analysis from downstream spring water which is about 1.5km from PPO site. The Tropical Pesticides Research Institute (TPRI)- UNIDO contractor, of Arusha helped in collecting the surface samples. Fourteen (14) samples out of the twenty nine samples taken during the PSI-S2 were sent to TPRI's laboratory for analysis. Soil sample for physical properties' analysis were to be analysed by the Project Technical Assistant at a later date to determine the geotechnical property of the soil in the contaminated area.

The Crew of Phase-2 Pilot project on contaminated sites

Surface sampling- PSI-S2

Surface sampling from the Maize field adjacent to the contaminated site

1.3 A visit to NHC-Morogoro Site- August 8, 2014

On August 7, 2014, Professor Loretta Li, Mr. Issaria Mangalili (national coordinator), and Mr. Nouri Abdalla, UNIDO Regional Coordinator for SADC sub-region, have travelled to Dar es Salaam. On August 8th, the three travelled by road to Morogoro town which is about 194km west of Dar es Salaam. The team spent August 8th surveying the NHC-Morogoro site, and conducting interviews with some local residents who live nearby the site. The NHC-Morogoro site is now rented out to a security company and the latter used part of the land and built dog kennels, and the kennels now house some dogs. The team then returned back to Arusha on August 9th.

While in Morogoro, the UNIDO team also met with Professor Ernest Semu of Skoine University of Agriculture (SUA). Prof. Semu indicated the need for UNIDO to sign a memorandum of understanding with SUA with regard to the implementation of the project and the involvement of the Project Technical Assistant (PTA), Ms. Mary Leina, in the project activities. The PTA has been enrolled for MSc Degree in Soil Science and Land Management. As part of MSc degree, Ms. Leina will use the work done at PPO-Tengeru Site and NHC-Morogoro Site for her research paper during her MSc program. Prof. Semu agreed to submit to UNIDO the standard postgraduate fees structure for SUA which

includes research costs, tuition fees, accommodation costs, and recommended stipend allowances to cover essential and basic personal expenses.

1.4 Detailed Site Investigation (DSI)- August 12-15, 2014

On August 12-15, 2014, a detailed site investigation was conducted at the PPO-Tengeru site. With the help of Water Solutions Drilling Company- UNIDO Contractor, eight (8) boreholes were dug at different locations in the site with special emphasis on the heavily contaminated area. The whole DSI process entailed drilling of eight boreholes and profile soil sample at interval of 50cm for each borehole was taken for chemical and physical properties analysis. Two boreholes were dug to a depth of seven (7) meters each and they were located about a half meter from the Old Storage Building, while the other six were dug to three (3) meters deep each. During the drilling for all boreholes, a sample was taken at every half a meter (50cm) level using air extraction. The samples were collected in amber bottles provided by TPRI and those samples were taken to TPRI's laboratory. In addition to samples collected in amber bottles for laboratory analysis, samples were also simultaneously collected in zip-lock bags (at each 50cm depth) to conduct soil particles analysis. Of the samples collected in amber bottles and sent to TPRI's laboratory, twelve samples were then analysed by the latter.

Profile core sampling- DSI

1.5 Pilot Project Team (PPT) meeting- August 15 & August 17, 2014

The PPT conducted a meeting on August 15th and August 17th, 2014 to assess the PSI-S2 and DSI processes. A list of tasks were then given by Professor Loretta Li to other members of the PPT, namely, Nouri Abdalla, UNIDO Regional Coordinator for SADC sub-region, Issaria Mangalili, National Project Coordinator, and Mary Dominick Leina, the Project Technical Assistant. *See Annex No 1. List of tasks for the members of the PPT*

2. General Observations

- The manual drilling using hand auger to obtain top soil sample (20 cm in depth) was quite tedious and time consuming due to soil compaction;
- The first three holes for top soil samples (PSI-S2) revealed the existence of thin plastic layer which was put by the Ministry of Agriculture staff a few years ago in an attempt to cover the emission of lindane (Gamma-Hexachlorocyclohexane) from the

soil and hence control the bad smell. This effort was not meant for remediation but rather reducing the bad smell;

- During drilling of the boreholes (DSI) it was discovered that the hard rock aquifer was at a depth of seven meters. This means that the loamy/volcanic soil layer, ends somewhere before seven meters and lindane could only be absorbed within this layer;
- It was discovered that, very few water drilling companies in the country exist which are able to perform geotechnical and environmental analysis. One positive note about Water Solution Drilling Company was that, it was able to provide continuous core sampling using air which was sufficient;
- The local laboratory (TPRI) selected to perform the sampling analysis on the samples collected during the PSI-S2 and DSI processes seemed to be a bit overwhelmed with the large number of samples needed to be analyzed in a short period of time. This caused repeated delays in providing the results according to the timeline agreed upon between the laboratory and UNIDO;
- The visit to NHC-Morogoro site has revealed that the site still poses a health risk to humans and environment. Empty bottles suspected to be the remnants from the previous DDT formulation plant are still found scattered in and around the site. The buildings which used for formulation and storage of DDT are still intact, but abandoned, however. Furthermore, the front side of the main building has been renovated recently and it is now rented out to a security company called Quick Security Company which uses the front offices as its headquarters. In the main area of the contaminated area, the security company built kennels for dogs and now these kennels are housing dogs of different breeds. It was also noticed that, some of the locals bring their animals (sheep and goats) to graze in the area of the site which is suspected to be heavily contaminated.

3. Conclusion and Recommendations

Phase-2 of the pilot demonstration project on cleaning up of contaminated sites at PPO-Tengeru site has been successfully concluded. Despite of all the challenges that faced the team that is working on the pilot project, all activities of Phase-2 were carried out as planned. The laboratory sample analysis has taken a bit longer than expected, however. The work of Water Solutions Drilling Company was quite satisfactory. The preliminary results of the samples analysis revealed that the area is contaminated and it needs to be remediated. The selection of a suitable remediation technology is dependent on final samples analysis taken during the DSI process and the cost of such technology.

Moreover, it has been recommended by the PPT that, the National Environmental Management Council (NEMC) and the Vice-President's Office (VP's Office) shall consider launching an awareness raising campaigns about the health risks associated with contaminated sites around the country. The PPO-Tengeru site could serve as a model out of which other contaminated sites in the country could be dealt with in the same manner with a special reference to be made to NHC-Morogoro site, where the National Housing

Corporation rented out the site to a security company without consulting with either NEMC or VP's Office.

Based on the findings of the laboratory samples analysis, and the amount of planning required thereafter, it is expected that the remediation process (Phase-3) of PPO-Tengeru site will take place in April, 2015. One of the technologies thought out by the lead scientist of the pilot project (Prof. Loretta Li) is phytoremediation. Very little information is available in the country, however, on the experience on utilizing of plants for phytoremediation of POPs contaminated sites. A few years ago, the University of Dar es Salaam in collaboration with NEMC has done some research on application of Vetiver grass (Chrosopogon Zizanioides). The research/study was done along the Msimbazi River at the old Vingunguti dumping site in Dar es Salaam. The study showed that Vetiver was found to be a fast growing grass with high yield, and can adapt to different types of soil and environment and has the ability to uptake and promote biodegradation of organic wastes.

Annexes

Annex No. 1: Tasks for Mission 2 Site Investigation Reporting

Tasks for Mission 2 Site Investigation Reporting include (drawn up by Prof. Li):

Nouri:

- Follow up with TPRI analytical results for the first batch of PROFILE SAMPLES – Joseph Malulu
- Follow up with TPRI analytical results for the surface samples (if the calculations, dilution factor and interpretation are correct) – Joseph Malulu.
- Surface sample results and profile samples results should be sent to me for check before forward to Mary and Mangalili to prepare the report.
- Report from Water Solution – Vincent
- Report from TPRI – Joseph Bukalasa, Loretta will provide sample report for Bukalasa.
- Possibility of removing the storage house. Coordinate with Juma and Mangalili

Loretta:

- Provide 2nd batch PROFILE SAMPLES for analysis.
- Lab QA/QC check
- Provide sample report for Bukalasa.
- Provide key points to Vincent for his report
- Supervise and provide National Project Co-ordinator (NPC) and Project Technical Assistant (PTA) to prepare PSI-S1 and DSI reporting.

Mary:

- Measure soil moisture contents
- Particle-size distributions by sieve analysis. Make sure keep all samples
- Follow work plan as discussed on Sunday August 17, 2014

Juma:

- To avoid contamination and protect work's health: Suggest to develop protocols and procedures for taking fuel from storage and same for pesticides.
- Look into the possibility of remove the storage house as it is formerly contaminated due to leaking of pesticides 20 years ago. Also contaminated by PAH since the storage house was built.**Mangalili and Mary:**

1) Prepare to a detailed report on Preliminary Site Investigation Stage 2 (PSI-S2):
   a) PSI-Stage 2 sampling, include sampling plan for media including water, soil, and plant samples
   b) Report chemical analysis results.
      i) Compile all relevant information
      ii) Identify all source zones, contaminants of concern, pathways for contaminant transport, and receptors based on analytical results.
      iii) Surface runoff

iv) Translate results into Figures and Tables

b) Data interpretation
   i) Identify data gaps, QA/QC, potential errors, etc.
c) Update conceptual site model
d) Conclusions and Recommendations

Complete by August 22

2) Prepare a professional technical report on DSI
   a) Compile profile information, chemical data
   b) Translate results into Figures and Tables
   c) Data interpretation
      i) Identify data gaps, QA/QC, potential errors, etc.
   d) Conclusions and Recommendations

Complete by September 7

Note:

- ***Read UNIDO Contaminated Site Investigation and Management Toolkit Chapter 2 Nigeria and Ghana case studies.***
- ***Follow these two case studies, prepare a technical report of above 1) and 2).***

Explore options and seek for information - Preparation for Remediation:

Nouri: co-ordinate with National Experts; National Project Co-ordinator (NPC) and Project Technical Assistant (PTA)

Mangalili:

- Find out the cost, ordering and shipment for flexible membrane liner material: Elastomeric: ES1, ES2; and technical experts. See information attached. Need to seek for contractor who has technical experts to install flexible membrane liners. Nouri will assist
- ***Locally*** available (i.e. in Arusha or Tanzania, not from other regions, for example India, NA etc.) phyto-plant species for pesticides remediation (non-edible plant species is preferred, grass species is good option as they grow quick and have good survival skill) and relevant information such as biodegradation, microbio-degradation, characteristics of the plant species, nutrients, etc. (Complete by September 8)
- Find out:
    - local civil engineering company for soil excavation and cost
    - Find out cost for soil relocation
    - Potential location for soil relocation within the same district and need procedures, e.g. permitting etc.
    - Transport of contaminated soil, permit?

Complete by September 1

Mary:

- Climatic condition in Arusha:
    - Wet/dry seasons, climatic information
    - Rainfall intensity: maximum daily rainfall, hourly rainfall
    - Corresponding daily temperature
    - Evapo-transpiration rate, soil infiltration rate (for borrow soil and in-situ soil)
- Flowering plant species with fragrance smell, but do not attract pests.
- Planting requirements and conditions, soil types.
- Water source for watering plants on-site.
- Any lawn grasses mats available to purchase

Complete by September 1

Annex No. 2: List of participants of Phase-2 of the Pilot Demo Project

List of participants of Phase 2 of the Pilot Demo Project on Contaminated Sites; PPO-Tengeru Site, Tengeru, Tanzania 30 July-20 August, 2014 Tengeru, Arusha Region, Tanzania

No	Name	Sex	Organization and Address	Email Address
1	Issaria Mangalili	M	Division of Environment, Vice President's Office, P.O.Box 5380, **Dar es Salaam**, Tanzania Mobile phone: +255-754 290 175 Fax: +255 22 211385	imangalili@yahoo.co.uk
2	Menan Jangu	M	National Environmental Management Council (NEMC) Northern zonal Office, **Arusha,** Tanzania Mobile: +255-767 53 5839	janmenan@gmail.com
3	Mohamed Mpina	M	Tanzania Pesticides Research Institute (TPRI), P.O. Box 3024, **Arusha,** Tanzania Mobile: +255-767 239 826 Fax: +255 27 250 8217	husseinmpina@yahoo.ie
4	Joseph Bukalasa	M	Tanzania Pesticides Research Institute (TPRI), P.O. Box 3024, **Arusha,** Tanzania Mobile: +255-759 201 632 Fax: +255 27 250 8217	josebukalasajs@hotmail.com
5	Lusajo Edward Ndaga	M	Government Chemist Laboratory Agency Northern Zonal Office P. O. Box 2095 **Arusha,** Tanzania	lusajo20@yahoo.com

			Mobile: +255-713 24 43 50	
6	Javinus Mbowe	M	Ministry of Agriculture, Food Security and Cooperatives, **Arusha Municipality**, Tanzania Mobile: +255-682 097870	mbowe.javinus@yahoo.com
7	Mary Dominick Leina	F	Ministry of Agriculture Food Security and Cooperatives, Plant Protection Office Tengeru, **Arusha,** Tanzania Mobile: +255-787 978 746	marydominick@ymail.com
8	Juma Hamisi Mwinyimkuu	M	Zonal Coordinator- PPO- Tengeru Ministry of Agriculture Food Security and Cooperatives, Plant Protection Office Tengeru, **Arusha,** Tanzania Mobile: +255-782689198	allymmm@yahoo.com
9	Nouri Abdalla	M	SADC Project Coordinator	nouriabdalla@yahoo.com
10	Loretta Li	F	UNIDO Consultant	lli@civil.ubc.ca
11	Tequam Tesfamariam	M	COMESA Project Coordinator	tequam1955@yahoo.com
12	Magdalena Mtenga	F	POPs Focal Point for Tanzania	magejohn@yahoo.com