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FINAL REPORT

SUMMARY

PROJECT: MONITORING OF MERCURY AND OTHER HEAVY METAL POLLUTION IN GOLD MINING AREAS AROUND LAKE VICTORIA, TANZANIA

CLIENT: NATIONAL ENVIRONMENT MANAGEMENT COUNCIL
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MONITORING OF MERCURY AND OTHER HEAVY METAL POLLUTION IN GOLD MINING AREAS AROUND LAKE VICTORIA, TANZANIA

SUMMARY

A geochemical study of gold mining areas in the Lake Victoria Goldfields has been undertaken to determine the environmetal impact of past and present gold mining activities and gold-ore processing. Samples of water, stream sediments and mine tailings collected from over twenty mining localities have been analysed for toxic and other heavy metals including Pb, Zn, Cu, Cd, As and Hg. Evidence for high Pb levels, upto 50% above permissible level in drinking water, is indicated in some water samples analysed. Copper, Zn, Cd and As concentrations in the samples are within permissible levels. High Hg concentrations (*mean* = 8.9 µg/l) in the water samples analysed indicate serious pollution of rivers by Hg-based gold recovery methods employed by "artisanal" miners.

Aqua regia-leachable heavy metal contents in river sediments from active gold mining and panning areas show enrichment factors of upto 12 relative to background concentrations, indicating contamination of the sediments by mining activities.

INTRODUCTION

The name "Lake Victoria Goldfields" refers collectively to a number of goldfields located in the Archean Nyanzian greenstone belt (> 2400 Ma) east and south of Lake Victoria in northwest Tanzania (Fig. 1). The Lake Victoria Goldfields (LVGF) are the largest and probably the richest in gold in Tanzania. Gold mining in the LVGF has an history of more than 85 years. Medium to large-scale gold mining was active between 1930's and early 1960's. Mechanised gold mining almost ceased soon after Tanzania (Tanganyika) got its independece in 1961, largely because of political reasons. The only mechanised gold mine to be opened in the LVGF in the last 25 years is the Buckreef mine in the Geita area south of the Lake Victoria (Fig. 1). With the closure of big mines, small scale, labour intensive gold mining ("artisanal" mining) by local people remained the source of gold production from the LVGF especially from mid 1980's. Liberalization of the mining industry in recent years has revalitilized gold exploration activities by local and foreign mining companies in the country. At present, however, artisanal gold mining is the principal source of gold production in Tanzania. From April 1990 to May 1993 artisanal miners with their primitive mining tools produced more than 11 tonnes of gold according to official reports. Most of this gold production came from the LVGF.

Although no systematic studies have been done so far to evaluate the environmetal impacts of long-lived and widespread gold mining industry in Tanzania, it is likely that the mining has caused disturbance and pertubations to natural habitat, soils, water systems, and communities (Nanyaro, 1989). For example, a recent environmental survey of mining areas in the Lake Victoria zone (Ikingura, 1992) has revealed a number of environmetal problems related to artisanal gold mining activities. The mining is generally haphazard and affect large areas of arable land. Where mining has ceased the land can not be used for farming or animal grazing because of many deep pits and piles of mine tailings which are left unattended. Apart from causing land degradation by pitting, artisanal gold mining caused other environmetal problems such as deforestation, water pollution and air pollution. High demand for wood for construction of living shelters, timbering of mine pits and for firewood has been identified as the main cause of deforestation. Pollution of water sources is attributed to gold-ore washing, panning and amalgamation with mercury. Decomposition of old mine tailings and acidic mine drainage also contributed to water pollution in some mining areas. Dust emanating from crushing and powdering of gold ore and mercury vapour resulting from firing of gold-mercury amalgams in open air have been found to be the main causes of air pollution in the artisanal gold mining areas.

Although various causes of environmetal problems in the LVGF have been identified, quantitative data about the extent of physical and chemical pollution of water, soil and air are generally lacking. The purpose of the present research is to study heavy metal dispersion patterns in areas with long history of gold mining with a view of identifying polluted areas which need remedial measures. Seven metals (i.e. Cu, Zn, Pb, Cr, Cd, As and Hg) have been selected for investigation in this initial stage of the study. The choice of the heavy metals included in the study has been influenced by two main factors. The presence of sulfidic gold ores (i.e. sulfide impregnation deposits (Harris, 1961)) and mine tailings which may be potential sources for the release of metals such as Cu, Zn, Pb and As into the environment is one of the factors. For examples gold ores in the Geita area south of Lake Victoria (Fig. 1) contain upto 20% sulfides. Another factor relates to the release of Hg and possibly Cd into the environment by anthropogenic activities in the gold mining areas.

SAMPLING AND ANALYTICAL PROCEDURES

Water, stream sediment and mine tailings samples were collected from both active and abandoned gold mining areas for geochemical study. Metal free sampling tools were used in the collection and storage of samples in order to avoid metal contamination. Water samples were collected from rivers, streams and water ponds. The samples were filtered and collected in 100 ml plastic bottles and conserved with pure concentrated nitric acid (HNO3) by adding about two drops of the acid per sample. Stream sediments were collected by scooping surface sediments using a plastic cup. Wet sediment samples and mine tailings were left to dry at room temperature in a dust-free room. Samples which caked upon drying were carefully loosened by squeezing the samples in plastic bags by hand or by hammering gently the samples with a light piece of wood in order to avoid crushing the samples. Dry samples were sieved through 2 mm plastic sieves, homogenised, quartered or spilt into two halves before sending the samples for analysis.

The water and sediment samples were analysed for Cu, Zn, Pb and Cd in our Geology Department geochemical laboratory. In addition, sediment samples were analysed for Cr. The sediment samples were treated with hot aqua regia to obtain leachable metal fraction. Metal contents in water samples and leach solutions were determined by flame atomic absorption spectrometric (AAS) method. Perkin Elmer AAS equipment model 2380 was used in the analysis. Details of sample preparation and analytical procedure are available from the University of Dar es Salaam Department of Geology geochemical laboratory. A few water and sediment samples were analysed for Hg and As at the Geological survey of Finland. Other water samples were analysed for Hg at the Government Chemist Laboratory in Dar es Salaam. Analytical precision for heavy metals analysed is within ± 5% except Pb for which the precision is within ± 10%.

RESULTS

Results of heavy metal analysis are presented in Tables 1, 2 and 4 and Figure 2. The analytical data are discussed in the following sections.

WATER ANALYSIS

Table 1 shows results of heavy metal analysis in water samples collected from 17 gold mining areas in the LVGF. Lead, Cu and Cd were detected in all water samples but in very low concentrations. Zinc was detected in 7 samples out of 40 samples analysed. Table 3 gives a summary of chemical concentrations of metals as recommended in WHO and Tanzania drinking water standards. Comparison of analytical data in Table 1 with data given in Table 3 for drinking water standards indicates the following: Cu, Cd and Zn concentrations in water samples from gold mining areas in the LVGF are within the range of permissible levels recommended in WHO and Tanzania drinking water standards. Out of 40 samples analysed, 12 samples (i.e. 30 %) show Pb concentrations that are above maximum permissible level of 0.10

mg/l in drinking water. The remaining samples (70 %) contain Pb concentrations that are within permissible level. Samples with anomalous Pb concentrations were collected from Buckreef, Nyarugusu, Nyakagwe, Mwakitolyo and Bulangamirwa gold mining areas south of Lake Victoria, and Buhemba and Nyabigena east of Lake Victoria (Fig. 1). Some of the anomalous samples contain Pb concentrations that are more than 50% above maximum permissible level.

Mercury and As concentrations in 9 samples analysed are shown in Table 2. Arsenic concentration in all but one sample is below the maximum permissible level of 50 µg/l in drinking water. Mercury concentration in the samples ranges from almost nil to 32.6 µg/l. The average concentration in the 9 water samples is 8.9 µg/l. Only two samples out of 9 (i.e. 22%) show Hg concentration that is within the maximum permissible level of 1 µg/l. The remaining (78 %) show concentrations that are significantly higher than the permissible level.

SEDIMENT ANALYSIS

Results of leachable heavy metal analysis for sediment samples collected from 4 main rivers (Thigithe, Mugusu, Nyikonga and Bujula-Butobera) in gold mining areas in the LVGF are presented in Table 4. At least two samples have been analysed from each river for reconnaissance study. In each case one of the samples was collected upstream away from gold mining and panning activities. Another sample was collected downstream in areas of active gold mining and panning as illustrated in Figure 2 for Thigithe river. If the metal contents in the samples collected from upstream are considered to represent background concentrations of leachable metals in the sediments then enrichment trend of the heavy metals is observed in samples collected downstream in areas of active gold mining and panning. In Figure 2, samples TG-3(s) and TG-4(s) from the Thigithe river show 1.5 to 2-fold increase in Pb, 2.5 to 9-fold increase in Cu, 5.5 to 6-fold increase in Zn, 2 to 3-fold increase in Cd, 39 to

42-fold increase in As and 9 to 12-fold increase in Hg concentrations but very little change in Cr concentration relative to sample TG-1(s) collected upstream. Sample TG-5(s) collected downstream almost 3 km away from gold mining and panning area shows relatively low Pb, Cu, Zn and Hg concentrations, indicating dilution of these metals in the sediments further downstream. One sample (NK-2(s)) collected from gold panning area along Nyamaku stream near old Mara mine has elevated Pb, Cu, Cd, As and Hg contents similar to those observed in the contaminated Thigithe river sediments.

Results for stream sediment samples from three rivers within active gold mining areas south of the Lake Victoria can be seen in Table 4. Sample MG-3(s) from gold panning area along the Mugusu river shows a 3-fold increase in Pb, 2-fold increase in in Cu, 7-fold increase in As and 9-fold increase in Hg while Cd remains almost unchanged relative to background concentrations in sample MG-5(s) collected upstream. Zinc and Cr show very little increase. Results for samples collected from Bujula-Butobera river show trends similar to Mugusu samples. Sample BU-2(s) from a vigorous gold panning area shows a 2-fold increase in Pb, 4-fold increase in Cu, 3-fold increase in Zn and 2.5-fold increase in Cr, 2-fold increase in As and 2.5-fold increase in Hg relative to background concentrations in sample BU-4(s) from upstream. Sample NG-4(s) from active gold panning area along Nyikonga river shows a 2-fold increase in Cu, 3.75-fold increase in Hg and at least 3-fold increase in Cd concentration relative to sample NG-6(s) collected upstream in an area with least gold panning activities. Pb and Zn occur in comparable concentrations in both samples while Cr and As are enriched in the upstream sample unlike other cases discussed above.

Four samples collected from mercury-treated mine tailings (KB-1(T), BT-1(T), MW-2(T), MW-4(T)) produced from crushing, powdering and panning of gold-bearing quartz vein ore were analysed. Although the analysed samples came from mining areas different from those drained by the three rivers discussed above, they serve to illustrate possible sources of metal contamination in some of the stream sediments. For example samples KB-1(T) and MW-2(T) from two artisanal mines (Ikombandulu and Mwakitolyo) south of Lake Victoria show high concentrations of Pb and Cd relative to the stream sediments analysed. High Pb and Cd in the tailings may be partly related to gold mining and processing tools used by the artisanal miners as discussed in the next section.

DISCUSSION AND CONCLUSION

Results of water analysis obtained in this reconnaissance study have shown that there is no obvious heavy metal contamination of water sources with respect to Cu, Zn and Cd, in the gold mining areas investigated within the LVGF. Possible Pb contamination of water sources is indicated in a few mining areas. Such areas need a more detailed follow up study to verify the extent of Pb contamination and to identify the sources of pollution. Arsenic contamination is indicated in one sample out of the 9 samples analysed. The contaminated sample (BH-1) was collected from a water pond used for domestic water requirements at Buhemba JKT camp. More sampling of the water pond will be necessary to ascertain the level of As contamination.

Mercury levels have been found to be significantly above the permissible level of 1 µg/l in drinking water, for 78% of the water samples analysed. Although only few water samples have been analysed for reconnaissance study, the results indicate that there is already mercury pollution problem in the gold mining areas investigated. If the Hg data are representative of the levels of Hg contamination in the LVGF rivers then the levels (mean 8.9 µg/l, range upto 32.6 µg/l) are remarkably high in comparison with mean Hg total water concentration of 1.56 µg/l and the range of upto 9.97 µg/l in the Madeira river basin of Brazil (Malm et al., 1990) or the range of upto 12.9 µg/l in contaminated Amazon rivers (Larceda and Salomons, 1991).

Interpretation of heavy metal distributions in stream sediments is often difficult because of many varibales that affect the distributions (e.g. mineralogy, grain size, organic matter content, metal extraction and analytical methods). Consequently, heavy metal pollution of sediments is often difficult to demonstrate. The approach commonly used is to compare the metal content of a surface sample with either a deep sample from the same area (Rognerud and Fjeld, 1993) or a surface sample from a distant area which is thought to be unpolluted (Trefry and Presley, 1976). Although the latter approach has got some short comings, it is fast and useful in reconnaissance studies of heavy metal distributions in sediments. Hence this approach has been used in the present study to compare leachable heavy metal contents in stream sediment samples collected upstream away from gold mining and panning activities with those in samples collected from areas of active gold panning. The results from all four rivers investigated show consistently, with only a few exceptions, increased concentrations (mostly by factors of 1.5 to 12 relative to background concentrations) of Cu, Pb, Zn, Cd, As and Hg in the sediments collected from areas of active gold mining and panning activities. Although only few sediment samples have been analysed in this reconnaissance study, the results indicate the presence of mercury and other heavy metal pollution in the river sediments from artisanal gold mining areas investigated.

Two possible sources of Cu, Pb, Zn and As pollution in the sediments studied include a) oxidation of sulfide minerals (e.g. chalcopyrite, galena, sphalerite, arsenopyrite) in mine tailings dumped into the rivers during gold panning and b) release of metals as a result of mechanical wear of simple tools used by artisanal miners in gold mining and panning. The latter may be a cause of point source Pb, Cd and Cr pollution in some of the mining areas. Deliberate addition of heavy metals in gold ore concentrates during mercury amalgamation to produce "fake gold" by unfaithful artisanal miners may also contribute to elevated Pb and possibly Cd contents in the mine tailings and finally in the river sediments.

Extensive use of Hg in the recovery of gold from pulverized rock material appears to be the principle and probably the only source of Hg contamination of river sediments in the LVGF. This is supported by the presence of high Hg contents in the mine tailings (mean 7.7 µg/g, range 1.31-18.7 µg/g). Dumping of mercury-treated tailings directly into river channels or along river banks by artisanal miners aggrevates mercury pollution of the river systems in the mining areas. Deposition of airborne mercury produced by firing of Au-Hg amalgams may also contribute to mercury pollution of soil and rivers as already found in the Amazon. Mercury levels in the river sediments from the LVGF (mean 1.94 µg/g, range 0.04-11.7 µg/g) are already high in comparison with an average of < 0.30 µg/g for world non-contaminated river sediments, but are within the range found in contaminated sediments in Amazon rivers (upto 19.8 µg/g, Larceda and Salomons, 1991). These initial results underscores the need for a comprehensive Hg pollution monitoring programme in various ecosystems within the Lake Victoria Goldfields.

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Table 1. Heavy metal analyses of water samples from gold mining areas in the Lake Victoria Goldfields

Locality	Pb mg/l	Cd mg/l	Cu mg/l	Zn mg/l
Geita*	0.02	0.007	0.074	ND
Mugusu				
Mean (N = 3)	0.05	0.012	0.049	--
Range	0.02-0.08	0.010-0.013	0.021-0.077	<0.002
Buckreef				
Mean (N = 3)	0.09	0.011	0.111	--
Range	0.07-0.11	0.008-0.016	0.045-0.171	<0.004
Mutukula*	0.07	0.012	0.017	ND
Nyarugusu				
Mean (N = 4)	0.06	0.003	0.093	ND
Range	0.02-0.15	0.001-0.005	0.031-0.163	--
Nyakagwe				
Mean (N = 4)	0.12	0.008	0.118	--
Range	0.06-0.16	0.002-0.012	0.023-0.215	<0.002
Bulyankhulu*	0.09	0.004	0.192	0.003
Mwakitolyo				
Mean (N = 2)	0.10	0.014	0.055	ND
Range	0.07-0.12	0.008-0.019	0.040-0.069	--
Katente				
Mean (N = 2)	0.07	0.003	0.044	ND
Range	0.05-0.08	0.003-0.003	0.032-0.055	--
Buhemba				
Mean (N = 3)	0.20	0.044	0.085	--
Range	0.15-0.25	0.007-0.019	0.014-0.179	<0.001
Majimoto				
Mean (N = 2)	0.09	0.004	0.028	ND
Range	0.08-0.10	0.001-0.007	0.021-0.035	--
Ikungu				
Mean (N = 2)	0.06	0.003	0.027	ND
Range	0.03-0.08	0.002-0.003	0.025-0.028	--
Nyabigena				
Mean (N = 2)	0.08	0.007	0.105	ND
Range	0.06-0.11	0.003-0.009	0.077-0.126	--
Moburama*	0.02	0.003	0.084	0.001
Nyamaku				
Mean (N = 2)	0.05	0.006	0.074	ND
Range	0.03-0.06	0.003-0.009	0.050-0.098	--
Bulangamirwa				
Mean (N = 2)	0.08	0.004	0.120	ND
Range	0.05-0.11	0.003-0.005	0.077-0.162	--
Kirondatal				
Mean (N = 2)	0.04	0.006	0.036	ND
Range	0.03-0.04	0.002-0.010	0.029-0.043	--

N: Number of samples, *: N=1, ND: Not detected; --: No value

Table 2. As and Hg analyses for water samples from four rivers in the Lake Victoria Goldfields

	As (ug/l)	Hg (ug/l)
<u>Thigite River</u>		
TG-3 (panning area)	3.95	32.6
TG-5 (3 km downstream)	9.48	1.7
<u>Mugusu River</u>		
MG-4 (upstream)	0.75	0.0*
MG-2 (panning/downstream)	16.20	10.4
<u>Bujula-Butobera River</u>		
BU-3 (panning/upstream)	2.38	9.5
BU-1 (panning/downstream)	2.02	2.8
<u>Nyikonga River</u>		
NG-5 (upstream)	0.56	0.7
NG-2 (panning/downstream)	0.31	21.8
<u>Buhemba Water Pond</u>		
BH-1	379	1.0

*: Not detected

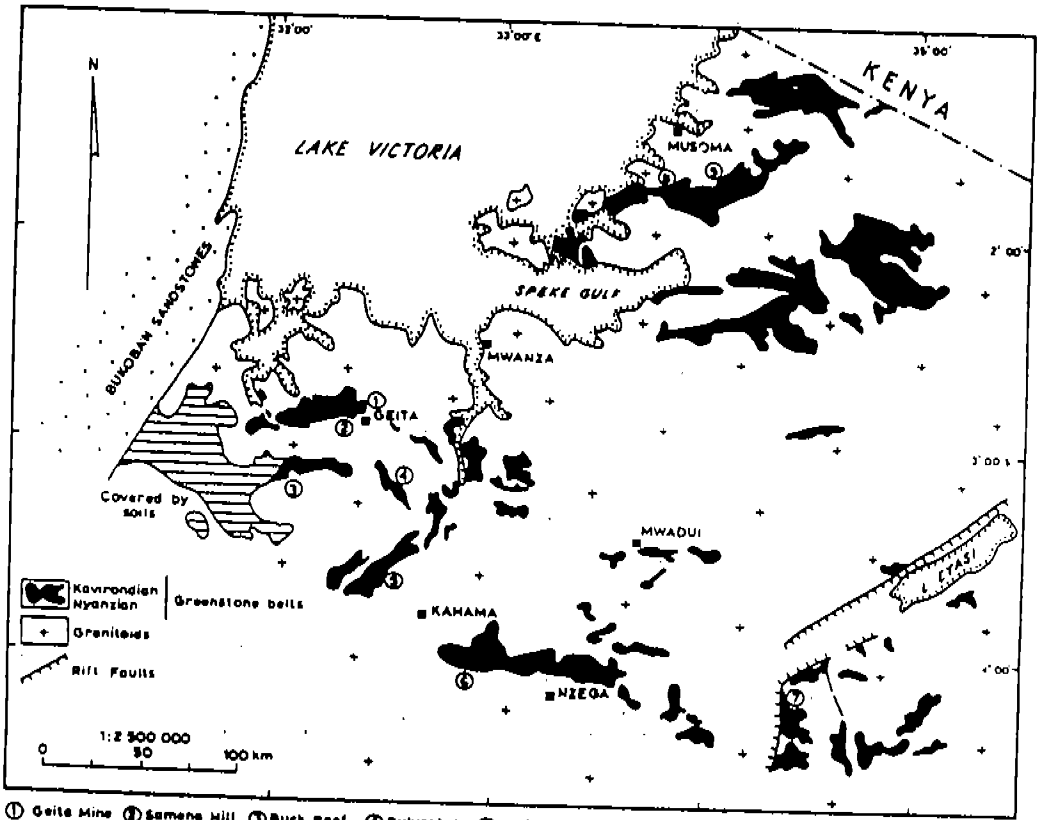
Table 3. WHO and Tanzanian Standards for Drinking Water

Substances	Unit	WHO highest desirable level	WHO Maximum permissible level	Tanzanian Standard
		Toxic substances		
Arsenic (As)	mg/l	---	0.05	0.05
Cadmium (Cd)	mg/l	---	0.01	0.05
Cyanide (CN)	mg/l	---	0.05	0.20
Lead (Pb)	mg/l	---	0.10	0.10
Mercury (Hg)	mg/l	---	0.001	---
Selenium (Se)	mg/l	---	0.01	0.05
Chromium (Cr)	mg/l	---	---	0.05
		Substances that may affect health		
Fluoride	mg/l	---	0.8	8
Nitrate	mg/l	---	45	100
		Substances affecting suitability for domestic use		
Colour	mg pt/l	5	50	50
Turbidity	JTU	5	25	30
Total solids	mg/l	500	1500	2000
pH	pH unit	7.0-8.5	6.5-9.2	6.5-9.2
Anionic detergents	mg/l	0.2	1	2
Mineral oil	mg/l	0.01	0.30	---
Phenolic compounds (as phenol)	mg/l	0.001	0.002	0.002
Total hardness	mg/l CaCO3	100	500	600
Calcium (Ca)	mg/l	75	200	---
Chloride (Cl)	mg/l	200	600	800
Copper (Cu)	mg/l	0.05	1.5	3.0
Iron (Total as Fe)	mg/l	0.1	1	1.0
Magnesium (Mg)	mg/l	30	50	---
Manganese (Mn)	mg/l	0.05	0.5	0.5
Sulphate (SO4)	mg/l	200	400	600
Zinc (Zn)	mg/l	5	15	15

Source: Coast/DSM Regions Water Master Plan, Vol. A, 1979.

Table 4. Leachable heavy metal concentrations (µg/g) for river sediments and mine tailings from Lake Victoria Goldfields

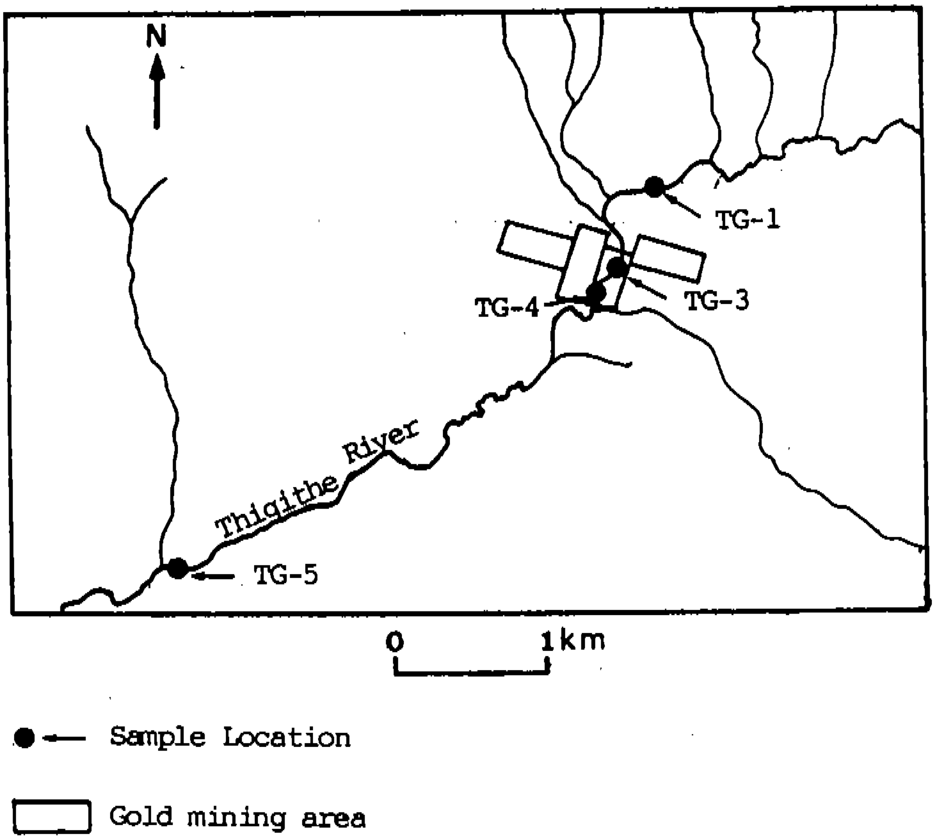
	Pb	Cu	Zn	Cd	Cr	As	Hg
<u>Thigithe River</u>							
TG-1(s) (*upstream*)	20.8	14.2	33.5	0.29	265	21.0	0.19
TG-3(s) (*panning area*)	39.9	125.8	186.6	0.62	317	876	2.35
TG-4(s) (*panning area*)	30.7	37.0	197.9	0.98	334	827	1.69
TG-5(s) (*downstream*)	17.4	9.4	25.5	0.56	311	34.9	0.16
<u>Nyamaku Stream</u>							
NK-2(s) (*panning area*)	60.8	20.3	35.7	0.74	157	147	3.00
<u>Mugusu River</u>							
MG-5(s) (*upstream*)	17.0	10.2	38.5	<0.1	258	11.6	1.36
MG-3(s) (*panning area*)	51.6	20.0	34.6	<0.1	277	84.0	11.70
<u>Bujula-Butobera River</u>							
BU-4(s) (*upstream*)	11.6	30.5	5.5	0.1	129	4.8	0.46
BU-2(s) (*panning area*)	25.2	121.5	18.3	<0.1	324	9.8	1.13
<u>Nyikonga River</u>							
NG-6(s) (*upstream*)	23.4	74.9	26.2	<0.1	1316	7.3	0.04
NG-4(s) (*panning area*)	20.0	144.8	33.8	0.29	439	2.0	0.31
<u>Tailings</u>							
KB-1(T)	96.2	30.7	33.5	1.06	217	10.6	1.31
BT-1(T)	11.1	12.1	24.0	0.16	98	0.5	1.56
MW-2(T)	49.4	55.8	72.3	2.78	384	977	6.71
MW-4(T)	10.0	11.4	8.7	0.14	13	1080	18.70



① Geita Mine ② Samena Hill ③ Buck Reef ④ Bulyanhulu ⑤ Jubilee Reef ⑥ Mahene ⑦ Sekenke-Irambe ⑧ Kiabakari ⑨ Buhemba

Fig. 1. Geological sketch map of the Lake Victoria Goldfields showing the major gold occurrences.

(After Van Straaten, 1982)



Ratios:	TG-3/TG-1	TG-4/TG-1	TG-5/TG-1
Pb	1.9	1.5	0.8
Cu	8.9	2.6	0.7
Zn	5.6	5.9	0.2
Cd	2.1	3.4	1.9
Cr	1.2	1.3	1.2
Hg	12.4	8.9	0.8
As	41.7	39.4	1.7

Fig. 2. Shows enrichment factors (relative to sample TG-1) of leachable heavy metals in sediment samples from Thighite river, east of Lake Victoria.

NATIONAL ENVIRONMENT MANAGEMENT COUNCIL (NEMC)

MONITORING THE FLOW AND END USE

PATTERN OF CHEMICALS IN TANZANIA

PHASE 2: DISTRIBUTION, HANDLING AND USE OF CHEMICAL

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1.0 INTRODUCTION

Phase I of this project was aimed at assessing the flow of chemicals into the country. It dealt specifically with identification of institutions/companies involved with importation of chemicals, their respective roles at various stages of importation, information flow and record keeping. This was an initial stage to obtain a reliable national information base to enhance sound chemical management in order to safeguard human health and environment.

The information on distribution, end-use pattern and disposal of chemicals consequent to importation has been cited to be equally important in determining the level of risk posed to human health and the environment.

This report is an outcome of a concluding remark made in the phase I report that an inventory (study) on the end-use (distribution, use, disposal) should follow immediately.

2.0 AREA OF STUDY:

The study was carried out in Dar es Salaam city. The choice of the area was based on its national status as the main commercial centre, port of entry for imported goods and industrial city. Due to this important role played by Dar es Salaam both in the trade and use of chemicals, it was expected that information gathered will be, to some extent, representative of other parts of the country. Five target groups dealing with chemicals were involved. The groups included distributors, industries, fumigators, laboratories (Research, teaching and Services) and transporters. Government Institutions dealing with chemicals management were also visited. (Appendix I).

3.0 OBJECTIVES OF THE STUDY:

(i) To collect compile and information on distribution of chemicals in the country.

(ii) To study the end use pattern of chemicals.

(iii) To assess the handling of chemicals at various stages.

(iv) To gather information on stocks of unused chemicals.

(v) To determine the risks posed to human health and environment as a consequences of chemicals mismanagement.

4.0 METHODOLOGY:

Different methods were used to obtain information from various sources. The methods include:

(i) Literature review

The report on phase I of this report was among sources of information.

(ii) Questionnaire

Different questionnaires were prepared according to target groups and dispatched (Appendix II). To test the respondents understanding, the questionaires were pre-tested before dispatch.

(iii) Visits

Places which received questionnaires were visited. The visit was followed in some undertakings, by brief inspection of stores, laboratories, disposal sites and the general environment.

(iv) Interview

Interviews were conducted to officials to cross-check responses given in the questionnaires.

(v) Documentation

This was a supplement to interviews and visits. Documents such as computer prints, lists of chemicals, brochures, pamphlets and chemical guidelines were thoroughly studied.

5.0 FINDINGS

The findings from the 14 institutions visited are presented hereafter.

5.1 Distribution of Chemicals

It has been revealed that chemicals are imported mainly from the United Kingdom, Germany, South Africa, France and Japan are distributed by importing private companies, retailers and government departments. The quantities ordered by importing companies are according to the market demands and therefore no stocks as chemicals are distributed to customers immediately upon receiving. For retailers and government departments, chemicals are kept in stores and/shelves until sold or distributed to end users.

Distribution of chemicals to various parts of the country is made possible by two major transport systems. These are railways and road. There are two railways, Tanzania Railways Corporation (TRC) and Tanzania Zambia Railways Authority (TAZARA). For both systems goods are received from customers including transport agents after declaring the contents of packages to customs/the relevant authorities.

The quantities distributed ranges from 4,206 tons/year and 593,260 litres/year in case of pesticides and 22,790 tons/year and 135,175 litres/year for industrial chemicals. (Appendix III & IV).

5.2 End-Use pattern:

Table 1: shows a summary of end-use pattern of chemicals as indicated by respondents of questionnaires.

Table 1

Group	Uses
Distributors	Pesticides: Used by large scale farms eg. NAFCO, SUDECO Breweries and small holder farms such as coffee, cotton, cashewnut and vegetable growers. Industrial chemicals sold for industrial use e.g. Textiles, soap manufacturing, water treatment, refrigeration, food processing, explosives (in quarrying and minerals prospecting), paper manufacturing and cigarette factories.
Industries	Mixed with other raw materials to manufacture adhesives, detergents and chemical auxiliary products.
Fumigators	Pesticides mainly are used for post-harvest, storage and public health.
Transporters	Various chemicals are used for cleaning parts of locomotives, fuel and in Quality assurance laboratory.
Laboratories	For research, general analytical work, teaching and technical services (consultancy).
Government Departments	Mainly pesticides used for crop protection (pre-and post harvest) against for example migrant pests. Some are used for public health.

5.3 Handling of Chemicals:

5.3.1 Storage:

It was found that 13 out of 14 respondents had their own or rented stores located several metres away from other offices. Most of these stores were kept at normal atmospheric conditions i.e. humidity and temperature. At the research laboratories, it was observed that chemical stores were air-conditioned and refrigerators were used to store chemicals which are supposed to be kept at low temperatures. Hazardous chemicals and solvents were isolated, i.e. placed in separate rooms.

Photo 1: Drums stored on the field outside

In other areas chemicals were kept in stores and in some cases those in drums were found lying on the field outside (photo 1). In most stores (13 out of 14 visited stores), chemicals were separated according to their categories, for example flammables, oxidizing, corrosive, etc. Among the used arrangement styles are pallets, racks and shelves. The storage arrangement in most cases was decided by the higher rank personnel (production manager or Managing director). The situation in research laboratories are different since technicians could also decide on the arrangement.

In some of the institutions, minor leakages/spillages of chemicals in some stores have been experienced.

5.3.2 Recording techniques of Chemical data

The common recording techniques used include filing and coding. However computer recording technique has been recently adopted by two of the visited respondents.

5.3.3 Personnel:

Personnel handling chemicals are found in stores, production areas, transporting systems and chemical application activities. Out of 14 respondents, 9 had storekeepers with basic general storekeeping training. Research institutions had qualified storekeepers as far as chemical storage is concerned. In production areas, it was found that only high level personnel had some know-how in chemical management. In transporting systems, the situation was pathetic since even casual labourers who handle chemicals, have not undergone any elementary training in chemicals handling.

5.3.4 Awareness:

Information on chemical safety is received from both local and foreign manufacturers and suppliers of chemicals in the form of international laboratory magazines, catalogues, brochures, booklets, leaflets and data sheets. (Appendix V). This information is usually in English and it is transmitted to handlers, in some cases without any ellaboration.

5.3.5 Protective gears:

All except one respondent, provide protective gear to chemical handlers. The gear include gloves, goggles, hats, gum boots and masks/respirators. Protective clothing such as laboratory coats (especially laboratory workers), aprons and overalls are also provided by the employer. However adequacy in terms of quantity and quality is doubtful. The issue of being used when required is also questionable.

5.4 Stock of Unused Chemicals:

It was revealed that distributors have no stocks of unused chemicals since they are keen to import just the amount required by customers.

Photo 2: Stocks of unused chemicals awaiting disposal

Stocks of unused chemicals were found in laboratories. At the University of Dar es Salaam Chemistry Department Laboratory, it was discovered through interview that a cocktail of chemicals some without labels have been in store for over thirty (30) years awaiting disposal. A similar situation was observed at the laboratory of the Chief Government Chemist where piles of unlabelled chemicals, some brought as samples for analysis were found.

It is however doubtful whether the information provided as regards stocks of unused chemicals is accurate. Many institutions/companies are usually reluctant to give true information fearing that it may have adverse effect to their business.

In Tanzania stocks of unused chemicals are unavoidable at least for the time being, due to a number of reasons which include:

- inadequate assessment of chemical requirements prior to donation or purchases.
- decreasing purchasing power of customers caused by rising prices of chemicals.
- unfavourable climatic conditions leading to death of crops before application of chemicals.
- non-occurrence of seasonal and migratory pests such as locusts, armyworms, queleaquelea etc.
- changing industrial production raw materials products, processes and laboratory analytical techniques.
- banning/restricting uses of some chemicals due to environmental and health reasons.

In case of pesticides, a survey was conducted by the National Environment Management Council in 1989 to assess the health and environmental hazards of stored and dumped pesticides in Tanzania Mainland. During the survey cases of dumped, expired and unused stocks of pesticides were found in various places such as private farms, cooperative unions and retail shops. Since no action has been taken up to now to dispose them, it is no doubt that such stocks can still be found.

5.5 Disposal facilities and practices

5.5.1 Facilities:

All visited places had no chemical disposal facilities.

5.5.2 Practices:

The common disposal practices cited include:

- burying
- open burning
- indiscriminate throwing (solids) and pouring (liquids).

Some companies take considerable effort to prevent the re-use of empty chemical containers by crushing them before they are taken to the city dumping site for disposal. In certain areas workers collected the empty containers and re-use them after washing.

For research, teaching and consultancy laboratories wastes resulting from reaction mixtures are poured in the sinks joining the main sewerage system.

In Dar es Salaam, groups such as women non-governmental organization involved themselves in collection and disposal of wastes including industrial waste as one of their income generating activity.

5.6 Risks to human health and environment:

5.6.1 Environment:

Absence of disposal facilities leads to accumulation and indiscriminate disposal of chemicals which is detrimental to the environment. Disposal practices noted earlier do as well cause air, soil, water and flora contamination. Contamination of the soil can be even more serious due to direct leakages from containers stored outside thereby affecting the ecosystem around.

During transportation, if an accident involving unknown dangerous cargo occurs, it may result into a disaster as there is no effective inspection before loading.

5.6.2 **Health:**

Most of health risks are associated with handling of chemicals. In other places only trade names of chemicals were available and therefore difficult to know their health or environmental risks. It is highly doubtful whether information on safe handling of chemicals reaches the chemical handlers and in case it reaches them, they may not be able to interpret it because of the language used (i.e. English).

This is justified by the responses given in the questionnaires that workers are not aware of both short and long term chemical risks.

For casual labourers who load/offload cargo, safety is not a priority as compared to financial gains to meet the basic needs of life (photo 3).

Photo 3: Casual Labourers off-loading pesticides

In areas where protective gears are provided, it has been observed that workers seldom use them. This may be due to inadequacy in terms of quantity, discomfort caused by hot climate and lack of training.

It was also noted that workers sometimes do share protective gear such as respirators. This tendency poses a risk of disease transmission in case the respirators are contaminated by diseases such as Tuberculosis.

Generally most chemical handlers were found not to have been formally trained in chemical management. However, the case was different for researchers, laboratory technicians and few supervisors who had basic knowledge either through formal training or job experience.

First aid facilities (mainly first aid boxes) were found to be present in almost all visited places however only 5 out of 14 had trained first aiders. Thus in case of an accident it may be very difficult to save the victim.

In case of transporters, health hazards are likely to be experienced by whoever is involved in their operations due to their interest in tonnage transported and not the contents.

Medical examination of workers is rarely conducted. Where they are examined, they undergo normal medical check-up regardless of their occupation. In Tanzania the number of specialized occupational health doctors is limited. Therefore most problems associated with chemical exposures are not identified early enough. According to the first schedule of the factories occupational services rules 1985, workers are supposed to be medically examined periodically depending on their occupation (Appendix VI). This is really done or enforced.

From the interview it was learnt that chemical related accidents do occur; for example in 1995, one worker in one laboratory was blinded by the splash of a chemical. Lack of records in regard to chemical accidents may be one among many reasons for poor respondence in this question.

In the past, other similar accidents have been identified as summarized in Table 2. However, the figures in this table may be far below the average due to several reasons e.g. under-reporting.

Table 2: Some data on chemical related accidents

Year	1979	1980	1981	1082	1983	1984	1985
Total accidents	3495	2920	3327	3182	3174	3485	3062
No. of chemical related accidents	76	78	92	92	201	12	92
% of chemical related accidents	2.17	2.67	2.76	2.89	6.33	3.53	3.07

Source: Reference 6

6.0 RECOMMENDATIONS

1. In order to have up to date information on chemicals used in the country, it is recommended that a register of industrial and laboratory chemicals be established. NEMC in collaboration with other relevant institutions could effect the same.

2. Efforts should be made to register and control industrial chemicals distributors. Renewable permits (comparable to those issued by TPRI in case of pesticides) could be issued after thorough inspection of premises, staff and equipment/facilities.

3. Observation of Prior Informed Consent Procedures - PIC (as contained in the London guidelines) is highly recommended. Current efforts by the Chief Government

Chemist to adopt PIC need encouragement and financial support.

4. Formation of an Association for industrial chemicals dealers similar to the Agrochemical Association of Tanzania (AAT) in case of pesticides to sensitize members or chemicals handling and use is recommended. (Appendix VII).

5. In order to minimize use and over-dependency on agrochemicals, alternative methods such as biocontrol need to be emphasized.

6. There must be integrated efforts by employers, government institutions and NGO's to train chemical handlers on safe use and handling of chemicals.

7. Sensitization of the public on chemical hazards through the mass media e.g. TV, radio, newspapers etc. is of utmost importance. Therefore such programmes should be conducted by bodies concerned with environment and health protection in order to create awareness in the general public.

8. Where necessary use of suitable protective gears need to be encouraged. Parallel to this, efforts should be made to find possibilities of local production of these gears to avoid importation of the same.

9. NEMC in collaboration with other relevant institutions need to develop simple and clear guidelines on disposal of chemicals and effect their use.

10. Regular medical examinations should be conducted to chemical handlers. Factory inspectors can be of much help in the timely enforcement of this.

11. To meet the intended objectives the above recommendations together with those given in previous studies (e.g. Phase 1 of this project) should be implemented rather than shelving them.

7.0 CONCLUDING REMARK

Although chemicals are needed in key sectors of our economy, their use and handling can cause considerable health and environmental hazards. Actions to initiate and improve activities aiming at reducing these hazards are therefore necessary. Improving the chemicals management and seeking alternatives to using toxic chemicals being among the required actions. Last but not least, to effect this exercise the follow up of chemicals life-cycle should be completed. Thus the inventory of unused, obsolete and expired chemicals followed by disposal exercise should follow immediately. NEMC should take a lead in seeking financial assistance for appropriate disposal of all chemical wastes present in the country.

8.0 REFERENCES:

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2. FAO, Provisional guidelines, Prevention of Accumulation of Obsolete pesticide stocks, 1995.

3. Mpendazoe F.M.T., 1990 Inventory and Assessment of Pesticide Storages in Tanzania 1990.

4. Rwazo A.J. M, Chemical import/export monitoring in Tanzania, a consultant final report for World Wide Fund for Nature (WWF) 1993.

5. Rwegoshora S.S.S. et al, Monitoring the flow and End-use pattern of chemicals in Tanzania, NEMC 1995.

6. Swai, D.A.T, 1993, Industrial Inspection: Problems and Experiences, a paper presented at the Seminar on Safe handling of Pesticides and other agrochemicals, Dodoma, Tanzania 19-23/4/93.

APPENDIX I

PLACES VISITED

Target group	Company/Institution/Department
Distributors	Technical Trading Services, Twiga Chemicals, Agricultural and Industrial Supplies Company (AISCO), Rhone Poulene (T) Ltd, Bytrade (T) Ltd, Consolidated Investment (T) Ltd.
Industries	Henkel, Twiga Chemicals
Fumigators	Rentokil (T) Ltd, Food Security Department
Transporters	Tanzania Railways Corporation Tanzania Zambia Railways Authority
Laboratories	The Laboratory of Chief Government Chemist Chemistry and Process and Chemical Engineering Laboratories (University of Dar es Salaam)
Government Institutions/Departments	Tropical Pesticides Research Institute (TPRI) Plant Protection Department (Ministry of Agriculture) National Environmental Management Council (NEMC) Factory Inspectorate
Others	Agrochemical Association of Tanzania (AAT)

APPENDIX II

NATIONAL ENVIRONMENTAL MANAGEMENT COUNCIL

Checklist : . Distribution and use of chemicals Date:--/--/1996

Name of institution: TRANSPORTERS

Number of employees: ....women.........men

* Please provide any available statistical data/information.
** Incase where space is not sufficient please write on a separate sheet of paper.

Q1. Function of a department/section . . . .
. . . .

Q2. A. Personnel dealing with handling (general/chemical)
. . . .
. . . .

B. His/her qualifications on chemical management
. . . .
. . . .

Q3. Chemicals are transported to . . . .
. . . .
. . . .

Q4. List the names and quantity of chemicals transported per year

Name Quantity

1. . . . .

2. . . . .

3. . . . .

4. . . . .

5. . . . .

6. . . . .

7. . . . .

8. . . . .

9. . . . .

10. . . . .

Q5. Which ones are most frequently transported

1................ 6. . . . .

2................ 7. . . . .

3................ 8. . . . .

4................. 9. . . . .

5................ 10. . . . .

Stock and quantities of chemicals which are not transported

Current stock:

. . . .

2. . . . .

3. . . . .

4. . . . .

5. . . . .

6. . . . .

7. . . . .

B. Average stock and quantity per year

name	quantity
1.........................	. . . .
2.........................	. . . .
3.........................	. . . .
4.........................	. . . .
5.........................	. . . .
6.........................	. . . .
7.........................	. . . .
8.........................	. . . .

Q7. A. Do you have any disposal facilities/methods
....

B. What are they?
....
....
....

Q8. Description of storage conditions

1. Temperature . . . .

2. Humidity . . . .

3. Leakages . . . .

4. Cleaning methods . . . .

5. Distance from storage to other offices......... meters

Q.9 Storage arrangement and separation categories:

Arrangement . . . .
. . . .
. . . .

Separation categories . . . .
. . . .
. . . .
. . . .

Q10. Any recording techniques? (coding/filling/Listing/computing)

Q11A.
Are the workers trained on safe use chemicals? Yes/No

Q11B. If yes, where were they trained? . . . .
. . . .
. . . .

Q12. Do they receive information on safe use of chemicals? Yes/No;
If yes where from . . . .
. . . .

Q13. Are they aware of chemical risks, both short and long term?
Yes/No
. . . .
. . . .

Q14. Do they use protective gears Ye/No, if yes who provide them.
. . . .

Please list types of the protective gears used.
. . . .
. . . .

Q15. How often are the workers medically examined, ...

Any cases of health effects identified during such examinations? . . . .
. . . .

Q16. Are there first aid facilities? Yes/No;

Are there any trained first aid providers? Yes/No.

Q17 Do you have any fire fighting equipment? Yes/No
If yes what type
1..........................2.............................
3..........................4.............................
5..........................6.............................

Q18 Are workers aware of the use of fire fighting equipment? Yes/No

Q19 Do you have any idea on the status of chemicals worldwide/Tanzania
(banned, severely restricted) Yes/No

Q20. A. Number of accidents occurred last year ....
Any deaths..................

B. Causes of the accidents . . . .
. . . .
. . . .
. . . .
. . . .
. . . .
. . . .
. . . .

NATIONAL ENVIRONMENT MANAGEMENT COUNCIL

Checklist : Distribution and use of chemicals Date: ....../...../1996

Name of institution: INDUSTRIES / DISTRIBUTORS

Number of employees: .... women.......... men......

* Place provide any available statistical data/information.

** Incase where space is not sufficient please write on a separate sheet of paper.

Q1. Function of a department/section ....

....

Q2. A. Personnel dealing with storage (general/chemical)

....

....

B. His/Her qualifications on chemical management

....

....

Q3. Chemicals are received from ....

....

....

Q4. List the names and quantity of chemicals received per year

	Name	Quantity
1.	....	....
2.	....	....
3.	....	....
4.	....	....
5.	....	....
6.	....	....
7.	....	....
8.	....	....
9.	....	....
10.	....	....

Q5. Which one are most frequently used/distributed

1.	....	6.	....
2.	....	7.	....
3.	....	8.	....
4.	....	9.	....
5.	....	10.	....

Q6. Stock and quantities of chemicals which are not in use

A. Current stock:

1. ....
2. ....
3. ....
4. ....
5. ....
6. ....
7. ....
8. ....

B. Average stock and quantity per year

	Name	Quantity
1.	....	....
2.	....	....
3.	....	....
4.	....	....
5.	....	....
6.	....	....
7.	....	....
8.	....	....

Q7. A. Do you have any disposal facilities/methods

....

B. What are they?

....
....
....

Q8. Description of storage conditions

1. Temperature ....
2. Leakages ....
3. Cleaning methods ....
4. Distance from storage to other offices .... meters

Q.9 Storage arrangement and separation categories:

Arrangement ....

....

....

Separation categories ....

....

....

Q10. How and where are the chemicals used?

.....

....

....

....

Q11. Any recording techniques? (coding/filling/Listing/Computing)

Q12. A Are the workers trained on safe use chemicals? Yes/No

B If yes, where were they trained?

....

Q13. A. Do they receive information on safe use of Chemicals? Yes/No?

B. If yes where from ....

....

Q14. Are they aware of Chemical risks both short and long term? Yes/No

....

....

Q15. Do they use protective gears Yes/No, if yes who provide them? ....

....

Please list types of the protective gears used.

....

....

Q16. How often are they Workers medically examined.

. ...

....

....

Have they been any cases of health effects identified during such examinations? ....

....

....

Q17. Are there any first aid facilities? Yes/NO

Are there any trained first aid providers? Yes/No.

Q18. Do you have any fire fighting equipment Yes/No.

If yes what type

1. .. ..
2. ....
3. ....
4. ....
6. ....
7. ....
8. ....
9. ....

Q19. Do workers aware of the use of fire fighting equipments? Yes/ NC

Q20. A. Number of accidents occurred last year ....

....

B. Causes of the accidents ....

....

....

....

NATIONAL ENVIRONMENT MANAGEMENT COUNCIL

Checklist: Distribution and use of chemicals Date: ....../...../1996

Name of institution: **LABORATORY**

Number of employees: .... women.......... men......

* Place provide any available statistical data/information.

** Incase where space is not sufficient please write on a separate sheet of paper.

Q1. Function of a department/section ....

....

Q2. A. Personnel dealing with storage (general/chemical)

....

....

B. His/Her qualifications on chemical management

....

....

Q3. Chemicals are received from ....

....

....

Q4. List the names and quantity of chemicals received per year

	Name	Quantity
1.	....	....
2.	....	....
3.	....	....
4.	....	....
5.	....	....
6.	....	....
7.	....	....
8.	....	....
9.	....	....
10.	....	....

Q5. Which one are most frequently used

1.	....	6.	....
2.	....	7.	....
3.	....	8.	....
4.	....	9.	....
5.	....	10.	....

Q6. Stock and quantities of chemicals which are not in use

A. Current stock:

1. ....
2. ....
3. ....
4. ....
5. ....
6. ....
7. ....
8. ....

B. Average stock and quantity per year

	Name	Quantity
1.	....	....
2.	....	....
3.	....	....
4.	....	....
5.	....	....
6.	....	....
7.	....	....
8.	....	....

Q7. A. Do you have any disposal facilities/methods

....

B. What are they?

....
....
....

Q8. Description of storage conditions

1. Temperature ....
2. Leakages ....
3. Cleaning methods ....
4. Distance from storage to other offices .... meters

Q.9 Storage arrangement and separation categories:

Arrangement ....

....

....

Separation categories ....

....

....

Q10. How and where are the chemicals used?

....

....

....

....

Q11. Any recording techniques? (coding/filling/Listing/Computing)

Q12. A Are the analyst trained on safe use chemicals? Yes/No

B If yes, where were they trained?

....

....

Q13. A. Do they receive information on safe use of Chemicals? Yes/No?

B. If yes where from ....

....

Q14. Are they aware of Chemical risks both short and long term? Yes/No

....

....

Q15. Do they use protective gears Yes/No, if yes who provide them? ....

....

Please list types of the protective gears used.

....

....

Q16. How often are they analysts medically examined,

....
....
....

Have they been any cases of health effects identified during such examinations? ....
....
....

Q17. Are there any first aid facilities? Yes/No
Are there any trained first aid providers? Yes/No.

Q18. Do you have any fire fighting equipment Yes/No.
If yes what type
1. ....
2. ....
3. ....
4. ....
6. ....
7. ....
8. ....
9. ....

Q19. Do workers aware of the use of fire fighting equipments? Yes/No.

Q20. A. Number of accidents occurred last year ....
....

B. Causes of the accidents ....
....
....
....

Trade Name	Common Name	Average Quantity per year
19. Marshal Suscon	Carbosulfan	4 MT
20. Nuvan 500	Dichlorvos	-
21. Pesguard PS 201	d- allethrin + d- permethrin	3400 kg
22. Phostoxin	Aluminuium phosphide	-
23. Rogor L40	Dimethoate	10000 lts
24. Selecron 720 EC	Profenofar	21000 lts
25. Sevln 85WP	Carbaryl	425 MT
26. Sherpa 1.8 ULV	Cypermethrin	5000 lts
27. Sumicidin 20 EC	Fenvalerate	4000 lts
28. Sumithion 50 EC	Fenitrothion	10000 lts
29. Thiodan	Endosulfan	30855 lts
30. Thionex 70% D	Endosulfan	2000 lts
<u>FUNGICIDES</u>		<u>All insecticides</u>:
31. Alto 100 SL	Cyproconazole	3000 lts
32. Antracol 70 WP	Propineb	339000 kg
33. Anvil 5 SC	Hexaconazole	2000 lts
34. Bayfidan 250 EC	Triademenol	1800 lts
35. Baytuan 150 FS	Triadimenol	800 lts
36. Bravo 500	Chlorothalonil	30029
37. Copper Cobox 50 WP	Copper Oxychloride	217.5 MT
38. Copper Nordox 50 WP	Cuprous Oxide	318.5 MT
39. Daconil 2787 W - 75	Chlorothalonil	4040 kg
40. Dithane M 45	Mancozeb	13251 kg
41. Funguran - OH 50 WP	Copper hydroxide	13000 kg

Trade Name	Common Name	Average quantity per year
42. Kocide 101	Copper hydroxide	44 MT
43. Perecopper 50 WP	Copper oxychloride	65 MT
44. Ridomil MZ 63.5 WP	Metalaxyl	20 kg
45. Sulphur	Sulphur	2575 MT
46. Topsin M-70% WP	Thiophanate-methyl	922 kg
<u>HERBICIDES</u>		<u>All fugicides</u>:
47. Basta	Glufosinate	4000 lts
48. 2,4-D Amine 720	2,4-D	61308 lts
49. Gramoxone 20 EC	Paraquat	47980 lts
50. Hyvar-X	Bromacil	5000 kg
51. Illoxan 36 EC	Diclofop - methyl	3000 lts
52. Puma Super	Fenoxaprop-ethyl	17600 lts
53. Rilof S 395 EC	Piperophos + Propanil	16800 lts
54. Ronstar 25 Ec	Oxadiazon	6343 lts
55. Roundup	Glyphosate	58118 lts
56. Satunil 60 Ec	Benthiocarb + Propanil	3685 lts
57. Stam UT - 8EC	Propanil + phenothiol	11200 lts
58. Stomp 500 EC	Pendamethrin	9267 lts
59. Touch down	Glyphosate x Trimesium salt)	6100 lts
<u>ACARICIDES</u>		<u>All herbicides</u>:
60. Bacdip 300 EC	Quintifos	5000 lts
61. Bayticol Pouron	Flumethrin	2000 lts
<u>NEMATICIDES</u>		
62. Furadan 5G	Carbofuran	60000 kg
63. Furadan 10G	Carbofuran	10MT

Trade Name	Common Name	Average quantity per year
64. Miral 10G	Isazophos	1000 kg
RODENTICIDES		
65. Racumin Block Bait	Diphacinon	2400 kg
66. Zinc Phosphide	-	1000 kg
AVICIDES		
67. Qucletox 60 ULV	Fenthion	3700 kg
TOTAL		

* Average values given in this study are only for the visited institutions

APPENDIX IV

CHEMICALS AND AVERAGE* QUANTITIES RECEIVED PER YEAR

Industrial and Laboratory Chemicals	Average Quantity Per Year
Acetic acid	100 tons
Acetone	700 lts
Allyl chloride	-
Aluminium sulphate	2500 tons
2-Amino pyridine	-
Ammonium chlorostanate	-
Ammonium nitrate	2000 tons
Ammonium thiocyanate	4 tons
Ammonium tungstate	-
Anhydrous ammonia gas	15000 lts
Barium chloride	5 tons
Benzene	13000 lts
Benzyl diphenyl	-
Borax	1.5 tons
Boric acid	1.0 tons
Butyl glycol	1.0 tons
Calcium carbonate	5.0 tons
Calcium hypochlorite	200 tons
Carbon tetrachloride	1000 lts
Citric acid	1.0 tons
Cycloheptanone	0.5 tons
Cyclohexanol	-
Diethyl ether	1000 lts
Dipropylene glycol	1.0 tons
Ethanol	1000 lts
Ethylacetate	3960 lts
Formaldehyde	3000 lts
Glycenine	1000 lts
Hexamethylene tetramine	0.5 tons
Hydrochloric acid	50000 lts

Industrial and Laboratory Chemicals	Average Quantity Per Year
Hydrogen peroxide	11000 lts
Isopropanol	3000 lts
Kerosene	6000 lts
Liquid ammonia	1000 lts
Maqnesium sulphate	1.0 tons
Methanol	1000 lts
Methylene chloride	80 tons
Nitric acid	3000 lts
Oxalic acid	1.0 tons
Potassium hydroxide	12.0 tons
Refrigerants	50.0 tons
Silica gel	0.5 tons
Soda ash	25 tons
Sodium bicarbonate	50 tons
Sodium carbonate	50 tons
Sodium chlorite	3 tons
Sodium formate	1 ton
Sodium gluconate	11 tons
Sodium hexametaphosphate	1.0 tons
Sodium hydrosulphite	10 tons
Sodium hydroxide	17000 tons
Sodium hypochlorite	2 tons
Sodium metasilicate	30 tons
Sodium perborate	1 ton
Sodium sulphate	600 tons
Sodium tripolyphosphate	40 tons
Sulpamic acid	500 lts
Sulfonic acid	1500 lts
Sulphuric acid	5000 lts
Toluene	13000 lts
Trichloroethane	0.5 ton
Trichloroethylene	500 lts

APPENDIX III

PESTICIDES AND AVERAGE* QUANTITIES RECEIVED

PER YEAR

Trade Name	Common Name	Average quantity per year active ingredient or formulated product
INSECTICIDES		
1. Actellic super Dust	Pirimiphos-methyl + Permethrin	50 MT
2. Actellic 50 EC	Pirimiphos methyl	-
3. Amdro	Hydramethylonon	556.8 kg
4. Baygon Aerosol	-	8460 lts
5. Bulldog vlv 005	Beta-cyfluthrin	34500 lts
6. Decis 25 EC	Deltamethrin	6000 lts
7. Diaznon 60 EC	Diazinon	6454 lts
8. Dimeeron 100 SW	Phosphamidon	5000 lts
9. Dursban 4E	Chlorpyrifos	66461 lts
10. Endosulphan D	Endosulphan	20000 kg
11. Ethylene Dibromide	Ethylene dibromide	33600 kg.
12. Fenitrothion 50EC	Fenitrothion	21000 lts
13. Fenitrothion 96 Techn.	Fenitrothion	10,000 lts
14. Icon 10 WP	Lambda-cyhalothrin	536.5 kg.
15. Karate EC	Lambda-cyhalothrin	4000 lts
16. Karate ED	Lambda-cyhalothrin	7500 lts
17. Karate 0.6 ULV	Lambda-cyhalothrin	50000 lts
18. Lebaycid 50 EC	Fenthion	1000 lts