出國報告（出國類別：其他：參加國際研討會）

參加2019年臺灣-菲律賓土壤及地下水污染整治工作技術交流展示活動

服務機關：　行政院環境保護署

姓名職稱：　何建仁 組長

派赴國家：　菲律賓馬尼拉

出國期間：　108年3月06日至3月09日

報告日期：　108年5月

摘　要

本署辦理「土壤及地下水污染整治工作國際合作計畫」，於新南向國家辦理土壤及地下水調查及整治技術的技術交流展示研習會以及場址環境勘查與評估工作，展現我國土壤及地下水調查與整治技術能力，協助新南向國家發展土壤及地下水相關業務並了解場址現況。

今年(108 年)3 月 6 日-3 月 9 日期間，於菲律賓辦理土水技術交流展示研習會，由國內 5 位產、學代表，依據菲律賓所提出之課程內容與技術需求規劃研習會內容，包含場址調查、廢棄物非法棄置場址調查、有機物污染調查等，同時亦介紹與展示重金屬污染調查常用的設備，本次會議共有 121 位專家學者與學生與會，會議主題獲得相當熱烈的迴響，對於我方提出之議題內容有諸多討論。3 月 9 日-12 日期間，由計畫委辦團隊邀請專家學者赴馬林杜克島辦理場址環境勘查與評估工作，協助菲律賓方面的參與團隊進行場址環境勘查的實務訓練，以完成銅礦場尾礦及其河川流域底泥污染調查。

工作期間亦拜訪菲律賓環境與自然資源部次長，洽談未來環境議題的長期合作事項，推動簽訂合作備忘錄做為環境議題交流與合作的基礎，並期望未來可以持續透過國際合作計畫，整合政府資源、產業界與學術界技術能力，以臺灣為土水技術發展的發動機，向新南向國家進行技術輸出，由政府帶頭產生母雞帶小雞的效應，協助我國環保產業向外拓展。

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為促進我國與亞太國家之國際環保交流，推廣我國環保技術與產業，尋求國際合作新契機，環保署自 99 年起即長期投入亞太地區國際交流工作，多次辦理國際研討會，展現我國土壤及地下水污染相關產業發展成果，同時舉辦技術交流展示研習會，協助東南亞國家提升土壤及地下水污染整治技術，推動臺灣成為亞太地區土壤及地下水領域的重鎮。

因應我國新南向政策及工程全球化政策，本署於 107 年「土壤及地下水污染整治工作國際合作計畫」(以下簡稱本計畫)改以主動出擊方式，規劃整合國內具有本土化技術產業與專家學者，實際走訪 ReSAG 夥伴國家辦理技術交流展示會與環境場址評估，透過實際執行場址環境評估、技術展示與技術訓練工作坊的方式，協助我國推廣土壤及地下水相關產業之技術，同時也輔導東南亞夥伴國家提升土壤及地下水污染整治技術。

經過初步評估與聯繫，本署選定之 ReSAG 夥伴國家為菲律賓與越南，本次出國行程則因應計畫 109 年 3 月 6 日 - 3 月 12 日間於菲律賓馬尼拉市之技術展示交流研習會與菲律賓馬林杜克島之場址環境勘查等活動辦理，主持技術交流展示研習會，同時拜菲律賓環境資源部以爭取未來台菲環保議題合作交流之永續性。

貳、出國行程與重點工作

一、行程

日期	地點	工作重點
108 年 03 月 06 日	台北 – 馬尼拉	啟程前往馬尼拉
108 年 03 月 07 日	馬尼拉	1.參加成功大學與瑪浦亞大學(Mapúa University)合辦之飲用水處理與優化研討會。 2.拜會菲律賓環境與自然資源部(Department of Environment and Natural Resource)次長 Jonas R. Leones 先生。
108 年 03 月 08 日	馬尼拉	參加 Taiwan – Philippines Workshop on Soil and Groundwater Contamination Site Investigation and Remediation 技術交流展示研習會，並做為引言人及與談人
108 年 03 月 09 日	馬尼拉 – 台北	回程，計畫委辦單位與專家學者前往馬林杜克島辦理場址環境勘查與評估工作。

二、參加人員

講師	職稱	服務單位	技術專長	備註
何建仁	組長	環保署土基會	土水污染調查整治規劃	致詞主持
吳庭年	教授	崑山科技大學	油品污染場址調查與整治	講師及現勘人員
方孟德	資深研究員	工業科技研究院	大型污染場址調查與整治、底泥污染調查與整治	講師
王炳南	經理	業興環境科技股份有限公司	污染場址調查與整治、綠色及永續整治、含氯有機溶劑生物整治	講師及現勘人員
高振棋	經理	業興環境科技股份有限公司	污染場址調查與整治、重金屬整治技術、油品現地整治技術	現勘人員
王穎淳	經理	喬哈斯科技股份限公司	重金屬污染調查與環境樣品分析技術	講師，重金屬快篩技術與設備係因應馬林杜克島調查需求選定
張漢予	董事長	瑞準科技股份有限公司	砷及重金屬快篩技術	講師，重金屬快篩技術與設備係因應馬林杜克島調查需求選定，為我國技術設備開發廠商

參、研討會與場址環境勘查活動成果說明

一、飲用水處理與優化研討會

飲用水處理與優化研討會係由科技部、臺灣自來水公司、成功大學、瑪浦亞大學共同合作辦理，會議共有 2 日，第 1 日主題討論臺灣與菲律賓自來水處理技術相關研究或成果，第二日則舉辦訓練課程，培訓與會者有關分子生物技術及藻毒偵測技術。臺灣方面，有來自成功大學環境工程系林財富教授、黃良銘教授、邱怡婷博士、自來水公司第六區管理處李丁來處長、中環科技公司陳佑瑄工程師，菲律賓方面則有馬尼拉環境管理局、漁業局、馬尼拉自來水公司專家與會，同時有多所大學的教授與學生與會。研討會議照片如圖一所示，研討會議程如表一所示，各講者演講主題與內容摘要如表二，簡報詳附件一。

透過第 1 日上午的交流討論，可知呂宋島大多是依賴河川水作為飲用水來源，局部區域可能會使用泉水或地下水作為飲用水來源，南部島嶼則因為基礎建設不足，仍有許多居民使用湧泉與地下水。目前菲律賓政府較重視地表水污染及廢棄物問題，尚未投入地下水資源的調查與管理工作，對於地下水污染相關基礎知識較為缺乏，而菲律賓境內有超過 50 座礦場，且存在廢棄物之非法棄置場址，嚴重影響地下水資源。我國可以地下水管理之相關經驗，作為未來雙邊技術交流主題。

(a)瑪浦亞大學合影

(b)飲用水處理與優化研討會與會者合影

圖一、飲用水處理與優化研討會照片

表一、飲用水處理與優化研討會議程

March 07, 2019

Time	Topic
08:30 – 09:00	Registration
09:00 – 09:30	Opening and Presentation: The Taiwan-Philippines Joint Water Quality Research and Innovation Center in Mapúa Univesity Prof. Delia B. Senoro *Mapúa University*
09:30 – 10:10	Topic: Overview of Drinking Water Quality Research at National Cheng Kung University Prof. Tsair-Fuh Lin *National Cheng Kung University*
10:10 – 10:30	**AM Break/Snack**
10:30 – 11:15	Topic: Progress in Water Treatment, Purification and Quality for Domestic Supply Engr. Ronald Padua *Maynilad Water Services Inc.*
11:15 – 12:00	Topic: Progress in Water Treatment, Purification and Quality for Domestic Supply Dr. Danvir Mark Farnazo *Manila Water Company Inc.*
12:00 – 13:00	Lunch
13:00 – 13:50	Topic: Treatment of cyanotoxin and T&O compound in drinking water systems. Prof. Tsair-Fuh Lin *National Cheng Kung University*
13:50 – 14:40	Topic: Biological treatment of drinking water. Prof. Langmuir Whang *National Cheng Kung University*
15:10 – 15:30	**Break/Snack**
15:30 – 16:20	Topic: Taiwan Water Corporation: current status and future perspectives Dr. Tin-Lai Lee *Taiwan Water Corporation (TWC)*
16:20 – 17:00	**Discussion / Q&A**

March 08, 2019

Time	Topic
09:00 – 09:30	Topic: Challenges in water quality monitoring and treatment operations Ma. Evangeline Rey Mellano *St. Joseph Water Services Corporation*
09:30 – 10:20	Topic: Application of Molecular Biology Technique for Cyanobacteria in TiaHu Lake. Mr. Yi-Hsuan Chen *CENPRO Technology Co. Ltd.*
10:20 – 11:10	Topic: Monitoring of cyanotoxin and odorant-producing cyanobacteria in drinking water reservoirs using real-time PCR. Dr. Yi-Ting Chiu *National Cheng Kung University*
11:10 – 12:00	**Discussion / Q&A**
12:00 – 13:00	Lunch
13:00 – 15:00	Hands-on training: Cyanobacteria identification and enumeration Dr. Yi-Ting Chiu *National Cheng Kung University*
15:00 – 17:00	Hands-on training: Flavor Profile Analysis (FPA) Dr. Yi-Ting Chiu *National Cheng Kung University*

表二、飲用水處理與優化研討會各講者報告摘要

演講者/講題	內容摘要
The Taiwan-Philippines Water Quality Research and Innovation Center in Mapua University (TP-WRIC) Prof. Delia B. Senoro	介紹臺灣、菲律賓於菲律賓瑪浦亞大學共同成立之水質研究與創新中心的目標、任務、歷程與階段性成果
Water Quality Research at National Cheng Kung University Prof. Tasir-Fuh Lin	1. 介紹成功大學水質研究團隊與研究成果 2. BioNET 氨氮移除技術與鳳山水庫模場與實場研究成果 3. 水庫水質受氣候變遷影響的研究成果 4. 水質監測與污染溯源技術 – 衛星、水下監測、無人機採樣與模式 5. 水質監測與分子生物技術應用成果
Progress in Water Treatment, Purification and Quality for Domestic Supply Engr. Ronaldo C. Padua	1. 介紹菲律賓 Maynilad 省自來水供水現況與淨水廠 2. Maynilad 省淨水廠面臨的問題(1)降雨造成的濁度不穩定(2)氨氮過高(3)錳濃度不穩定(4)總溶解固體物濃度高 3. 解決方案包含溶解氣體浮除、生物好氧過濾、超濾與逆滲透
Progress in Water Treatment, Purification and Quality for Domestic Supply. Dr. Danvir Mark Farnazo	1.介紹 Manila water company 2.目前 Manila water company 在處理水庫水源所面臨的問題(1)原水水量不足、(2)取水口水位過低、(3)原水水質不良 3.短期方案與長期處理方案
Monitoring and Treatment of Cyanotoxins and Taste and Odor Compounds in Drinking Water Systems Prof. Tsair-Fuh Lin	1. 介紹淨水廠藍綠藻產生的藻毒、臭味與異味問題 2. 介紹利用氧化劑處理藍綠藻與其代謝產物的評估模式與藻毒預測模式 3. 臭味、異味的來源與分析方法與臺灣的案例
Biological treatment of drinking water. Prof. Langmuir Whang	1. 介紹淨水廠生物處理程序 2. 說明生物快濾法的歷史、演進、設計與最新進展 3. 利用鳳山水庫淨水廠模場試驗結果說明生物快濾法效果與其脫硝應用
Taiwan Water Corporation: current status and future perspectives Dr. Tin-Lai Lee	1. 說明臺灣水資源問題與自來水公司任務 2. 介紹台灣自來水處理方法，在地下水部份說明以地下水為水源的處理程序 3. 說明目前臺灣自來水供水所面臨的問題、解決方案與現況

二、拜會菲律賓環境與資源部

本次出國行程期間，透過我國駐菲律賓代表處劉漢青組長及蔡乙儂秘書的安排，前往菲律賓環境與自然資源部拜會次長 Jonas R. Leones 先生，討論未來雙邊環保合作交流議題，會議中向 Leones 次長說明本次拜會目的，並介紹由本署邀集亞洲國家共同組成的 ReSAG 組織，以及每年於台灣舉辦之土壤及地下水訓練課程，會議中並邀請 Leones 先生參加並成為 ReSAG 菲律賓的代表，本次拜會行程與議程如表三，報告使用之簡報如附件二所示。

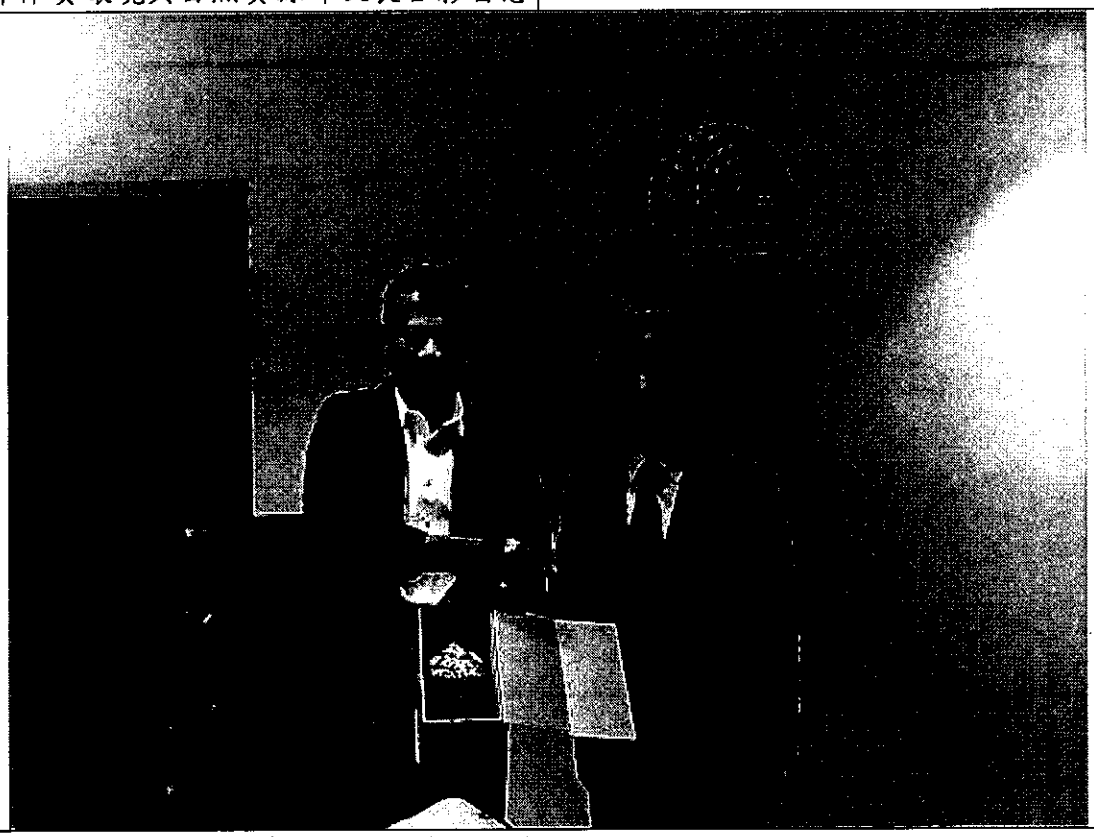
Leones 次長對於本署推動之國際合作計畫展現高度興趣，允諾未來可親自參與 ReSAG 交流活動，亦將參加近期之視訊會議，另將派員來臺參加本署舉辦之技術訓練課程。除此之外，Leones 次長相當關切我國提出的環保議題合作備忘錄進度，將儘速召集相關單位與我國駐菲代表處逐條討論合作備忘錄內容，以儘速簽訂合作備忘錄。

Leones 次長於會議中提出菲律賓近期主要環保任務為馬尼拉灣治理與地表水管理工作，期望我國可以提出技術協助，本署則提出過去進行愛河流域整治管理、二仁溪重金屬污染底泥整治及宵裏溪流域新興污染物源頭管理等經驗與 Leones 次長分享。Leones 次長展現高度興趣，本項議題涉及廢棄物管理、地表水管理與港灣底泥調查等問題，未來或可由本署組織相關團隊，協助菲律賓透過亞洲開發銀行及世界銀行，辦理馬尼拉灣治理相關工作。

表三、拜會菲律賓環境與資源部行程與議程

時間	地點	工作內容
11:00-14:00	交通移動	自瑪浦亞大學啟程前往駐菲律賓代表處後轉往菲律賓環境與自然資源部
14:00-14:30	菲律賓環境與自然資源部	1. 說明本次訪菲行程與目的
14:30-15:50		2. 雙邊環保合作交流議題討論
15:50-16:00		3. 交換禮物與合影
16:00 – 18:00	交通移動	自菲律賓環境與自然資源部返回旅館

(a)與菲律賓環境與自然資源部次長合影留念



(b) 與菲律賓環境與自然資源部次長合影留念

圖二、拜會菲律賓環境與自然資源部次長照片

三、土壤及地下水調查與整治技術交流展示研習會

3 月 8 日則由本署計畫委辦單位臺灣土壤及地下水環境保護協會、成功大學假菲律賓瑪浦亞大學舉辦土壤及地下水污染調查與整治技術交流研習會，本次會議共有 121 位來自多所菲律賓大學、越南、史瓦濟蘭、瑞典、臺灣等國家交換學生及專家學者與會。技術交流研習會議程與內容概要如表四所示。

表四、土壤及地下水調查與整治技術交流展示研習會議程

時間	主題	主講人	內容綱要
09:00 - 09:30	報到		
09:30-09:40	開場致詞	Prof. Bonifacio T. Doma, Jr. 菲律賓瑪浦亞大學 何建仁 組長 行政院環保署 林財富 教授 國立成功大學	
09:40-10:20	污染場址調查與技術	王炳南 經理 業興環境科技股份有限公司	1.污染場址調查概論 2.土壤及地下水污染調查技術
10:20-10:50	Coffee break		
10:50-11:30	廢棄物非法棄置場址調查與鑑識案例	方孟德博士 組長/資深研究員 工業科技研究院	1.大型污染場址調查方法 2.廢棄物非法棄置場址調查與案例
11:30-12:10	XRF 原理與土水調查案例	王穎淳 經理 科邁斯科技股份有限公司	1. XRF 技術原理 2.土壤及地下水污染調查案例 3.XRF 設備展示與 Demo
12:10-13:30	午餐		
13:30-14:10	新穎砷及重金屬快篩工具介紹 – 原理與案例	張漢予 總經理 瑞準科技股份有限公司	1.水中重金屬電化學方法檢測原理與發展 2.As 快篩案例 3.As 快篩技術設備展示與 Demo
14:10-14:50	油品污染調查與整治技術	吳庭年 教授 崑山科技大學	1.油品污染調查技術 2.油品污染整治技術 3.油品污染場址調查與技術案例
14:50-15:10	Coffee break		
15:10-16:00	含氯有機溶劑污染調查與整治技術	王炳南 經理 業興環境科技股份有限公司	1.含氯有機溶劑污染調查技術與案例 2.含氯有機溶劑污染整治技術概論
16:00-16:30	綜合討論	Delia B. Senoro 主持	所有與會者討論與回答問題
16:30	賦歸		

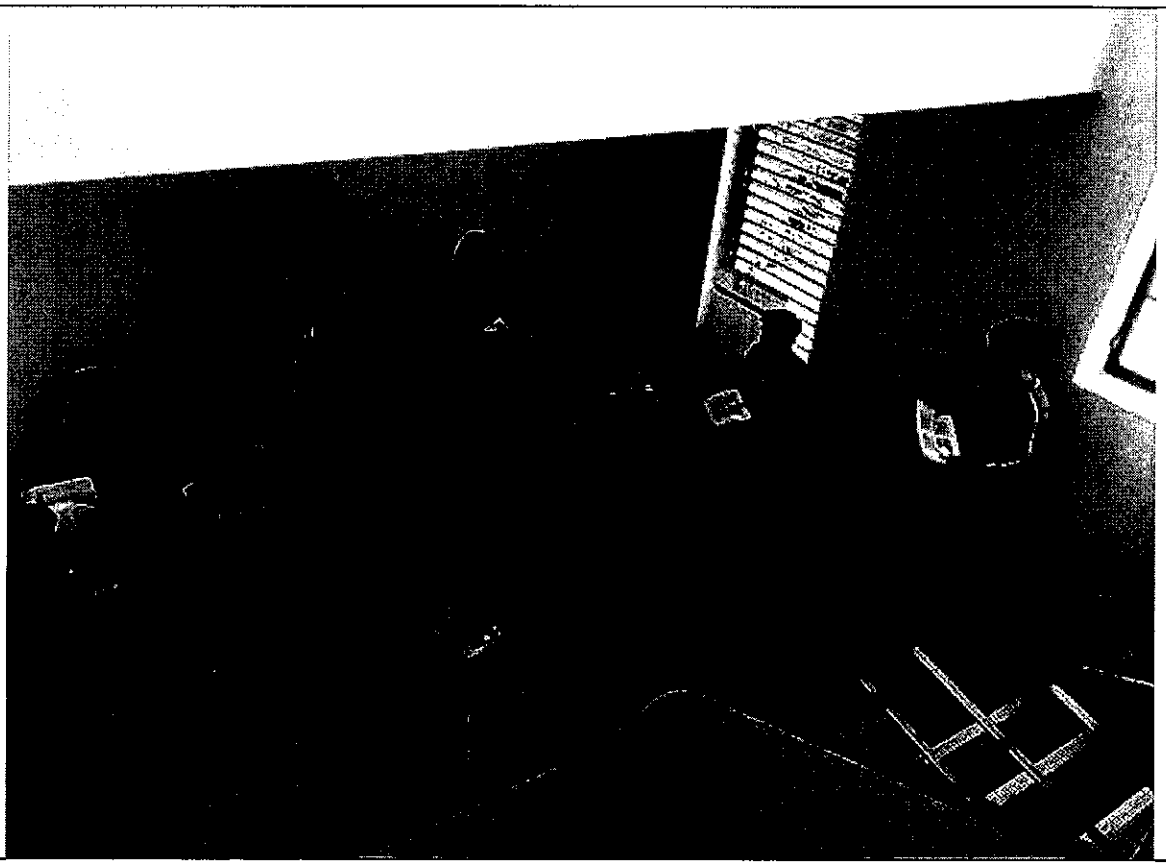
本次技術要求研習會內容係依據協辦單位瑪浦亞大學提出之需求，邀請我國學術界與產業界分享我國在污染場址調查評估、大型廢棄物非法棄置場址調查與鑑識、油品污染場址調查與整治、含氯有機溶劑污染場址之調查與整治等經驗，並由我國設備廠商攜帶 XRF 與水中重金屬砷快篩設備，作為技術展示與交流展示之用，並於技術交流研習會後，攜帶 XRF 設備進行場址環境勘查過程污染表徵與污染濃度初判之用，研習會各講者簡報如附件三，各講者報告內容摘要說明如表五所示，研習會照片如圖三所示。

表五、土壤及地下水調查與整治技術交流展示研習會各講者報告摘要

演講者/講題	內容摘要
Introduction on Soil and Groundwater Contamination and Site Assessment Bing Nan Wang	1. 說明土壤及地下水污染來源與種類 2. 場址環境評估內容、程序與應注意事項 3. 場址污染調查工具、結果與案例說明，包含地物方法、土壤氣體調查方法、土壤採樣方法、地下水調查與採樣方法、連續貫入調查方法等
Contamination Forensics and Post-treatment Planning of an illegal dumping site in Taiwan Meng-Der Fang	1. 非法棄置場址問題 2. 非法棄置場址調查程序與方法 3. 歷史空照圖應用與廢棄物量體估計方法 4. 非法棄置場址綠色整治策略
Experience of rapid heavy metal elemental analysis by XRF in Taiwan Ying-Chun, Wang	1. 臺灣土壤及地下水污染法規介紹 2. 高解析度場址調查與 GIS 軟體應用呈現 3. XRF 原理與分析干擾說明 4.XRF 設備應用、功能說明、操作示範
A novel screening tool for As and heavy metals contamination in water A case study in Taiwan. Hans Chang	1.臺灣砷污染問題與監測的挑戰 2.水中砷濃度分析方法介紹與比較 3.電化學方法分析水中砷濃度原理 4.電化學方法臺灣應用案例 5.電化學砷快速檢測分析設備應用、功能說明與操作示範
Petroleum Compounds Contaminated Site Investigation and Remediation Technologies Dr. Ting-NienWu	1. 臺灣油品污染問題 2. 加油站污染調查規劃原則 3. 油品污染整治技術介紹 4. 臺灣加油站污染場址整治案例介紹-過嶺加油站、一心加油站
Introduction of Chlorinated-Solvent Contaminated Site Investigation and Remediation Bing Nan Wang	1. 含氯有機溶劑污染特性與污染分布 2. 含氯有機溶劑污染調查規劃與結果–案例說明 3. 含氯有機溶劑污染整治工法介紹 – 以案例說明不同整治技術

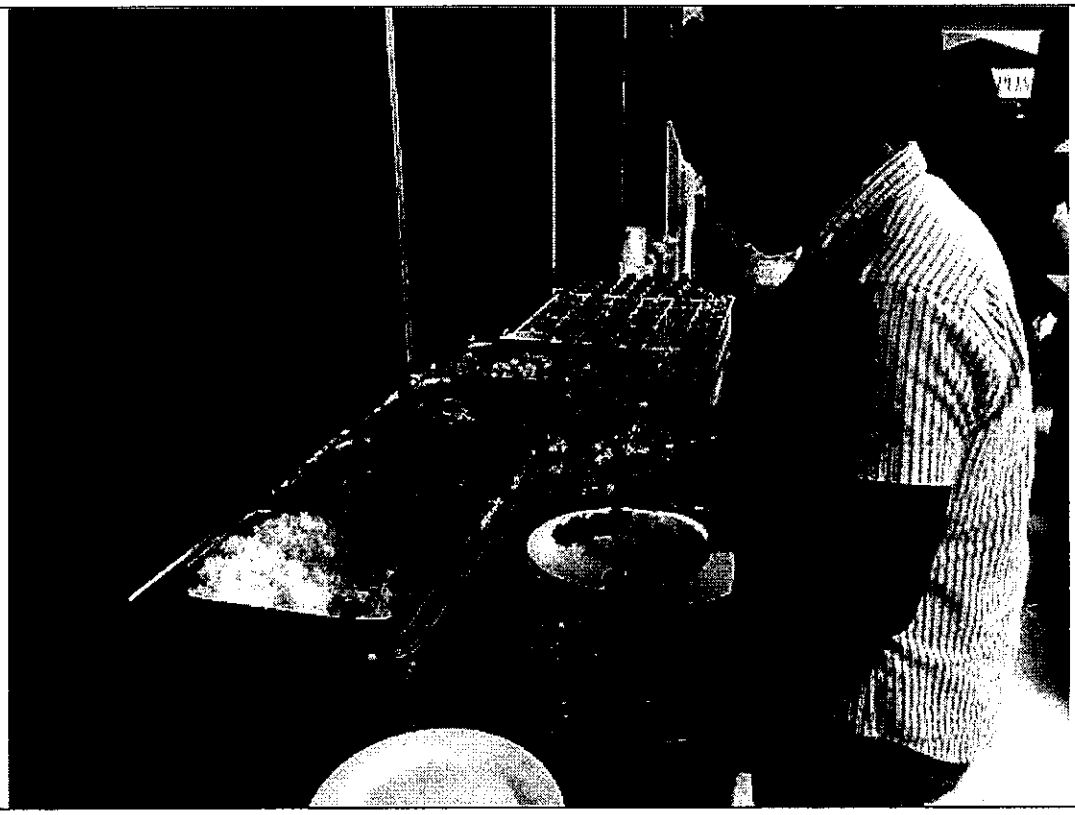
與會者對於本署與專家所發表之土壤及地下水污染調查與整治相關知識、技術與設備展現高度興趣，然由與會者發問可知，菲律賓各界對於土壤及地下水議題的認知仍屬起步階段，未來可透過更多的技術交流活動，協助菲律賓建立相關專業知識與能力。

(a) 技術交流展示研習會報到

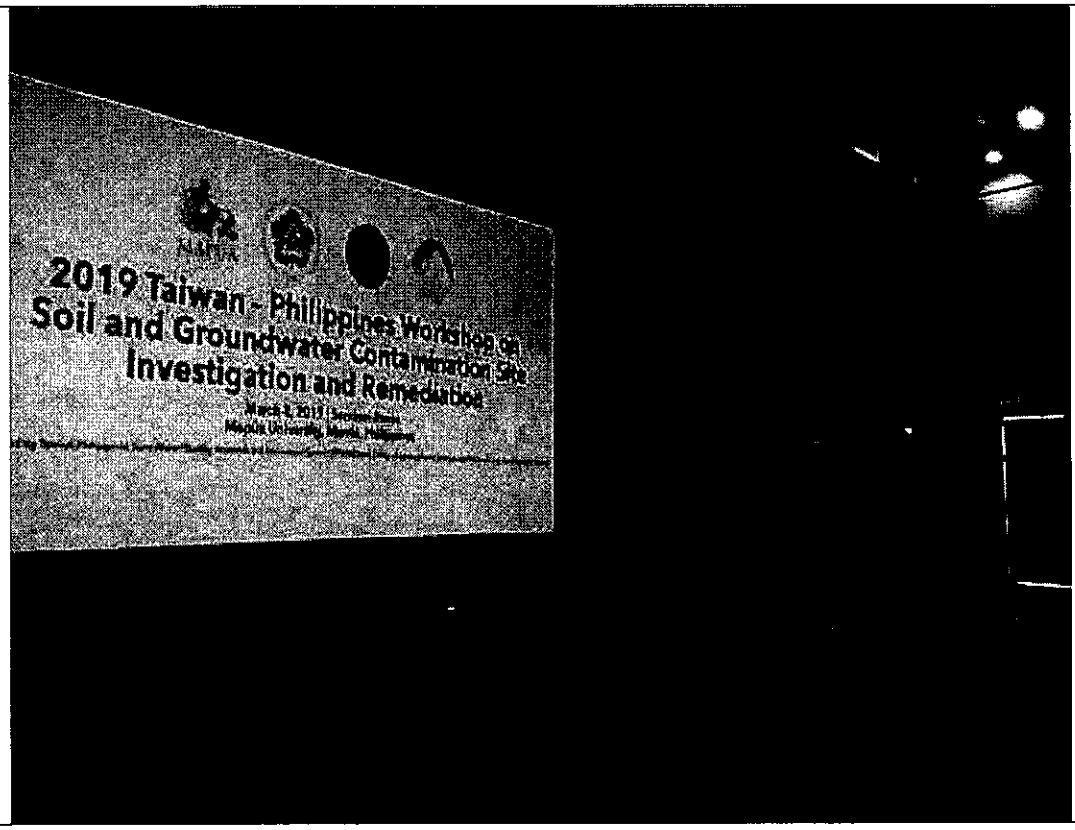


圖三、土壤及地下水調查與整治技術交流展示研習會會議過程照片

(b) 技術交流展示研習會餐點

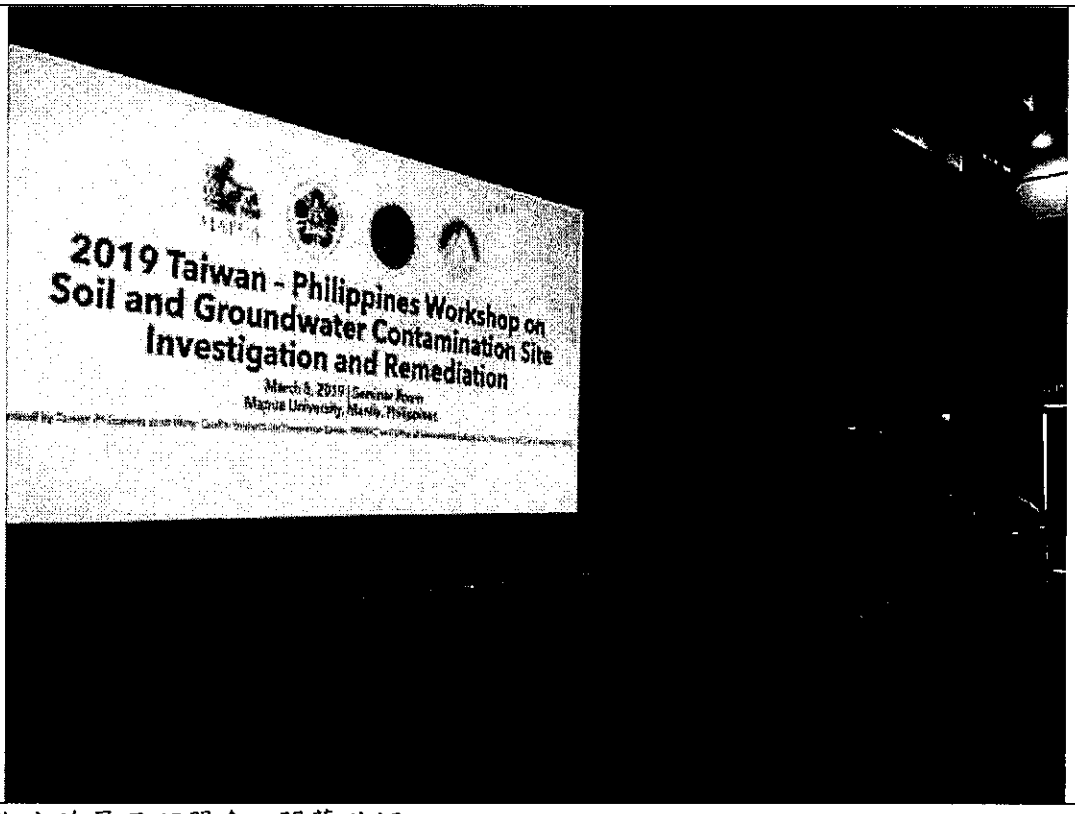


(c) 技術交流展示研習會- 副校長 Prof. Bonifacio T. Doma, Jr.致詞

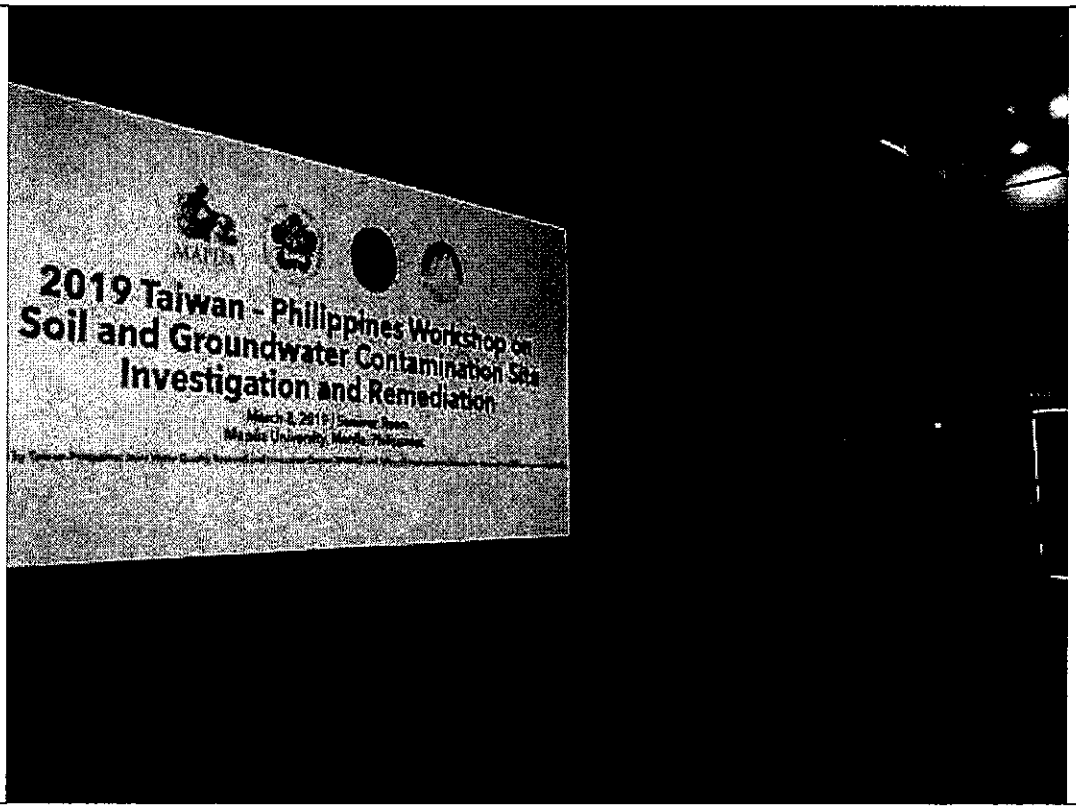


圖三、土壤及地下水調查與整治技術交流展示研習會會議過程照片(續)

(d) 技術交流展示研習會- 林財富教授致詞

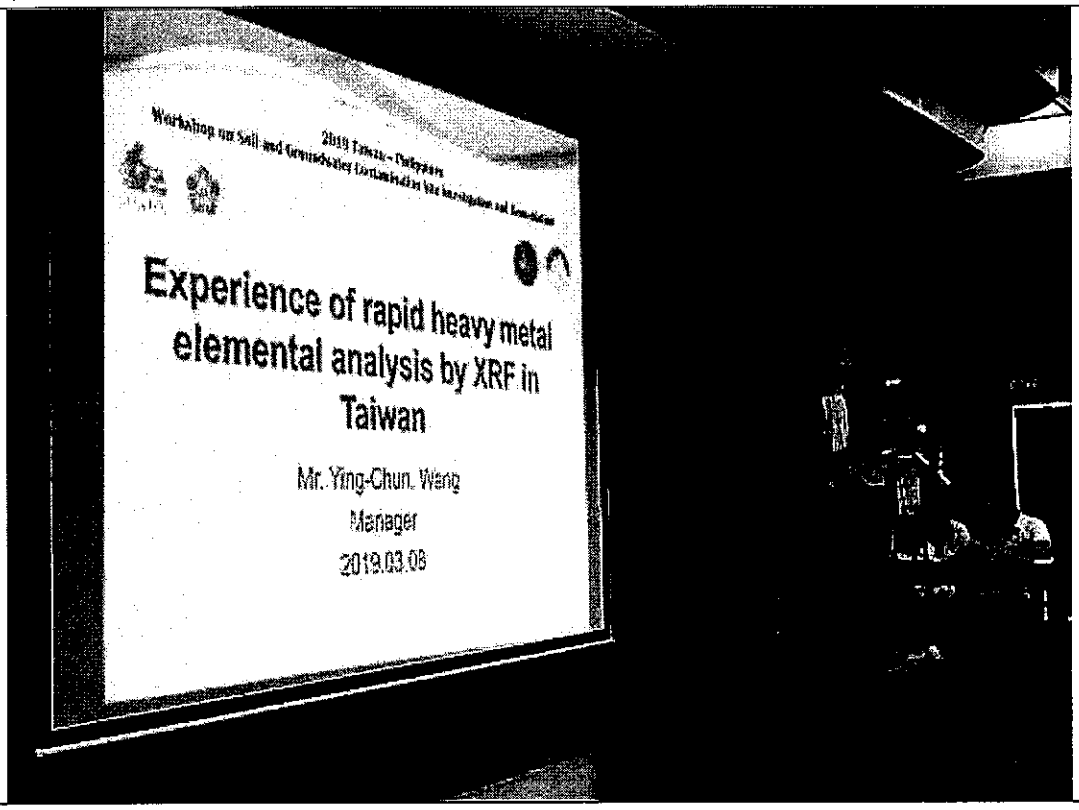


(e) 技術交流展示研習會- 開幕致詞



圖三、土壤及地下水調查與整治技術交流展示研習會會議過程照片(續)

(f) 設備展示與介紹



(g) 環保署回覆問題

圖三、土壤及地下水調查與整治技術交流展示研習會會議過程照片(續)

(h) 講師授予感謝狀

圖三、土壤及地下水調查與整治技術交流展示研習會會議過程照片(續)

四、場址環境勘查與評估工作與設備展示與訓練

依據本署委辦計畫工作內容要求，承辦團隊於 3 月 9 日-3 月 12 日期間，會同瑪浦亞大學調查團隊與馬林杜克學院調查團隊，前往受銅礦尾礦污染的馬林杜克島進行場址環境勘查與評估工作，場址環境勘查評估工作行程如表六所示。

馬林杜克島位於菲律賓呂宋島的南方，面積約為 952.6 平方公里，是菲律賓南方一個具有港口與機場的海島。馬林杜克島過去為菲律賓重要的銅礦場(Marcopper)，因為採用露天開採的方式，遺留大量廢棄礦渣，1993 年 Marcopper 北側尾礦坑發生潰堤事件，影響北側 Mogpog river，1996 年時，因加拿大馬爾寇伯礦業公司的煤渣屏障坍塌而導致有毒礦物散落進入 Boac river 流域，影響土壤、地下水、地表水及鄰近海域。場址可能存在各種重金屬污染及煉銅過程所使用的化學藥劑污染，如氫化物等。本次污染場址環境勘查評估工作，因應菲律賓提出之需求，針對島上的大型礦場與 Mogpog river 與 Boac river 流域進行現勘，並配合 XRF 之使用，快速判定表層污染狀況與污染濃度分布，同時依據現勘結果提出後續

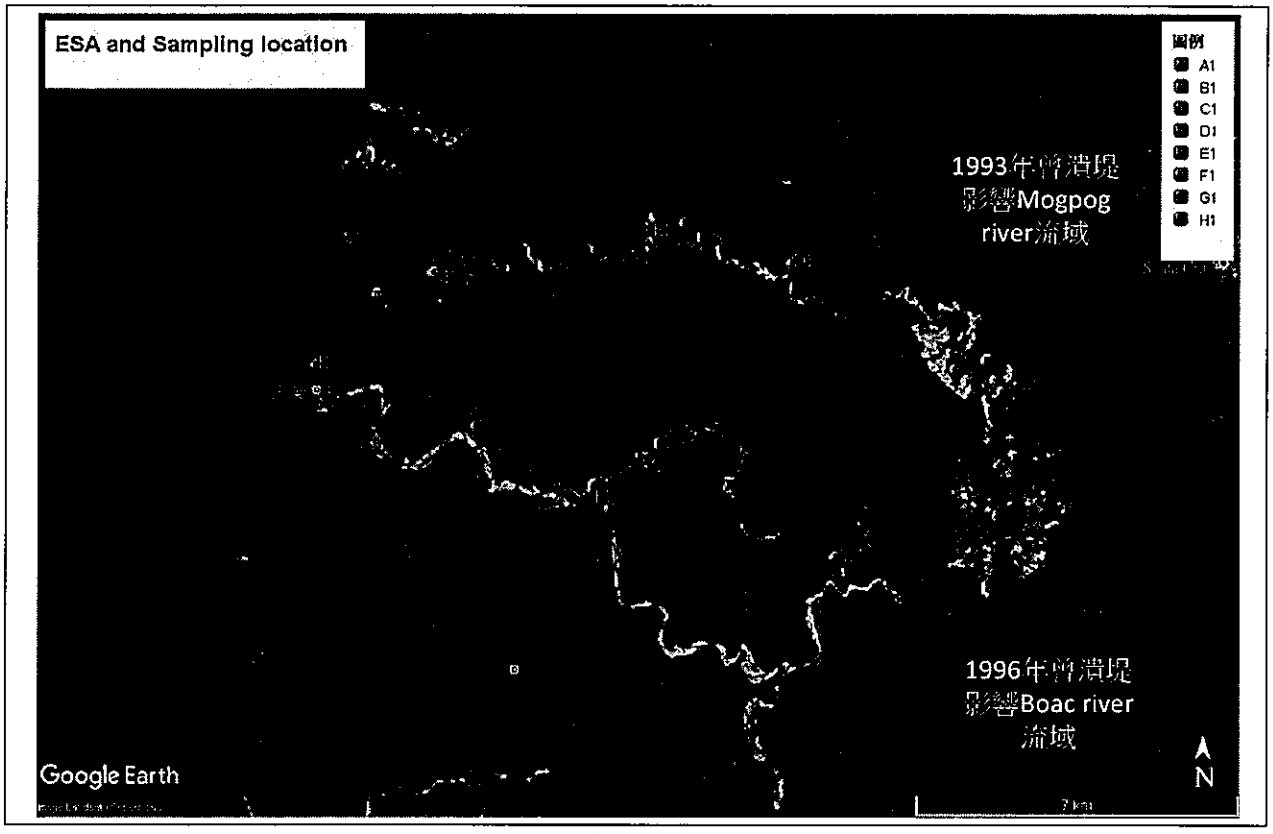
建議與可行管理方針建議。

表六、場址環境勘查與評估工作行程與內容概述

時間	地點	內容綱要
3 月 9 日 移動日		
07:00 – 13:00	馬尼拉市至盧賽納(Lucena)碼頭	交通移動
13:30 – 17:00	盧賽納至馬林杜克島巴拉納坎(Balanacan)碼頭	渡輪移動
17:00 – 18:00	馬林杜克島下榻旅館	
3 月 10 日 Boac River 上游河床、Marcopper 北側礦場、Mogpog river 上游河床		
07:30 – 11:00	Boac River 上游河床	當地民眾溝通與嚮導、河床現勘、底泥採樣與快篩
11:00 – 14:00	San Antonio 村落	當地民眾溝通與嚮導
14:00 – 16:00	Marcopper 北側礦場	礦場與尾礦場現勘、表土採樣與快篩
16:00 – 18:00	Mogpog river 上游河床	當地民眾溝通與嚮導、河床現勘、底泥採樣與快篩
3 月 11 日 Mogpog river 中游河床、Boac River 中、下游與河口、馬林杜克學院拜會及演講		
07:30 – 08:30	Mogpog river 中游河床	當地民眾溝通與嚮導、河床現勘、底泥採樣與快篩
08:30 – 14:00	Boac River 中、下游與河口	當地民眾溝通與嚮導、河床現勘、底泥採樣與快篩
14:30 – 16:00	馬林杜克學院	演講
16:00 – 17:00	馬林杜克學院	拜會 Marinduque State College)校長 Merian Catajay-Mani 女士
3 月 12 日 移動日		
13:00 - 14:00	馬林杜克島	移動至碼頭
14:30 – 17:00	巴拉納坎(Balanacan)碼頭至盧賽納碼頭	渡輪移動返回呂宋島
17:00 – 22:00	盧賽納至馬尼拉市	車輛移動返回馬尼拉，抵達下榻旅館

本次現勘與採樣區域如圖四所示，場址環境勘查與採樣分析工作照片如圖五所示。由初篩結果可知於 Marcopper 北側積水坑取得知土壤樣品銅濃度並不高，這可能是因為北側礦場淺層(0-10cm)土壤大多是銅礦開採後殘留的礫石，故土壤中銅濃度反而較低，或因 XRF 設備模組限制而無法直接反應污染濃度，但靠近積水坑處土壤銅濃度則略高。由積水水色與植被生長狀況及葉片黃斑與葉緣黃化情況判斷，開挖坑與尾礦填埋區域重金屬濃度仍高，且對於鄰近地表水與地下水水質仍具有嚴重威脅。

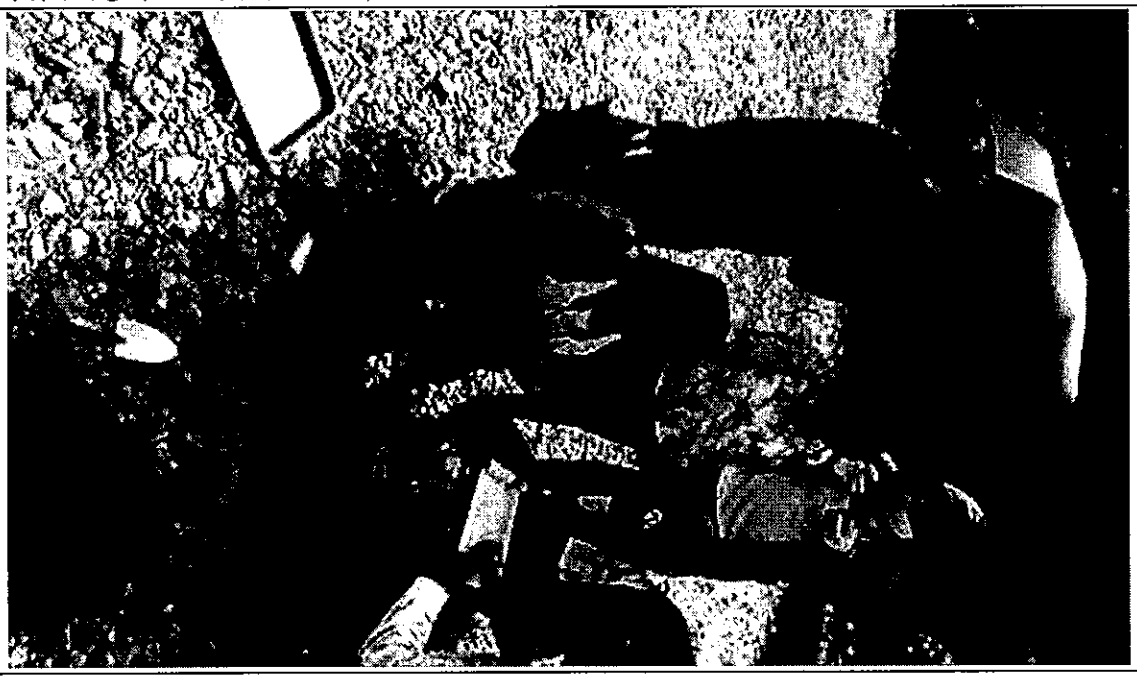
由 Mogpog river 與 Boac river 流域底泥重金屬分布如圖六所示，顯示到目前為止 1993 年與 1996 年礦坑潰堤事件仍對 2 個河川流域存在重大影響。由歷年空照圖變化亦可推測，礦坑在停止開採後受地表水逕流與雨水累積而積水成湖，礦坑中的積水仍可能透過優勢路徑進入 2 個河川流域當中。不同採樣區位底泥/土壤樣品 XRF 快篩結果顯示，外距離 Marcopper 礦場越近，則底泥中銅平均濃度越高。Mogpog river 的底泥銅濃度在 E 區的樣品濃度下降，顯示酸礦水對於 Mogpog river 的影響距離較短，而對礦坑的滲出水 Boac river 流域底泥影響距離較長，至 G 區的濃度仍高，H 區的底泥樣品濃度則以降低至一般的土壤背景濃度以下。但從取得的土壤背景濃度來看，土壤中的銅濃度仍有偏高的情況，接近或超過臺灣土壤污染管制標準(400mg/kg)，這可能是因為馬林杜克島的土壤是來自銅濃度較高的母岩風化或是農業行為所造成。



圖四、馬林杜克島場址環境勘查區位

(a) 馬林杜克島現勘與採樣分析 Boac River

(b) 馬林杜克島現勘與採樣分析 Boac River



圖五、馬林杜克島場址環境勘查工作行程與照片

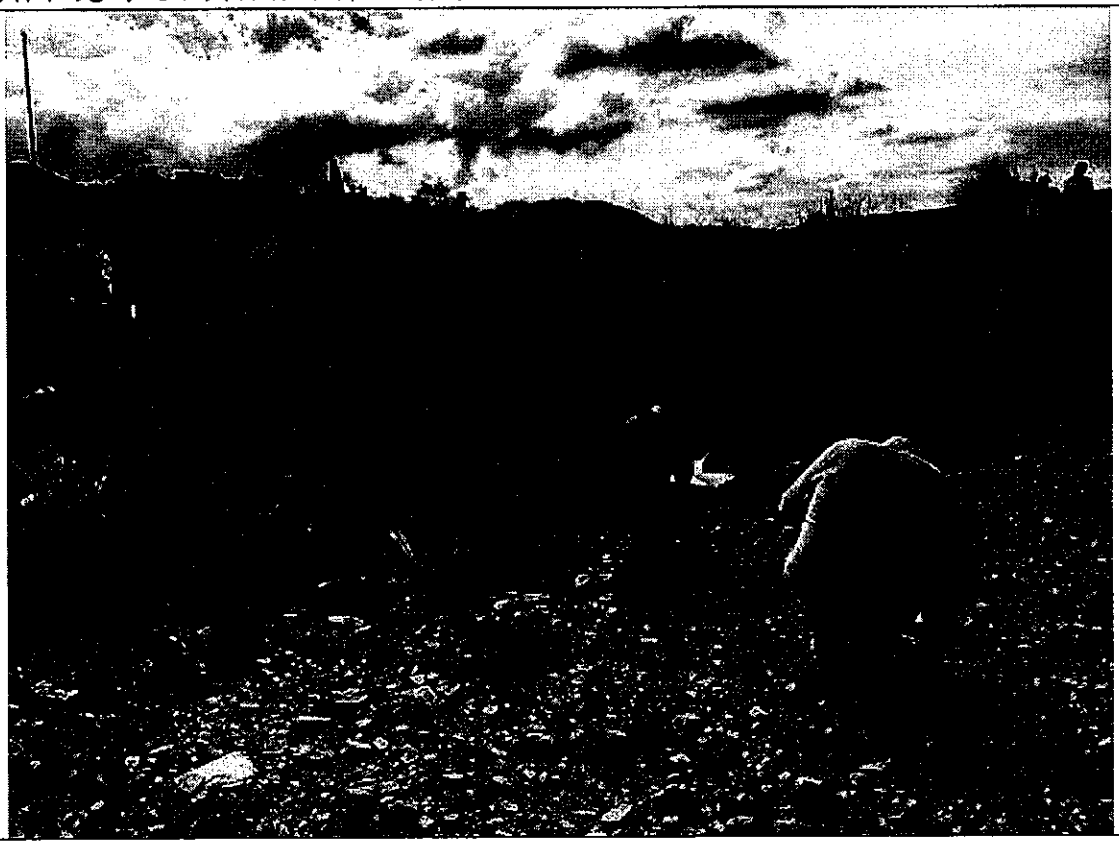
(c) 馬林杜克島現勘與採樣分析-銅礦場

(d) 馬林杜克島現勘與採樣分析-銅礦場

圖五、馬林杜克島場址環境勘查工作行程與照片(續)

(e) 馬林杜克島現勘與採樣分析-銅礦場

(f) 馬林杜克島現勘與採樣分析-銅礦場



圖五、馬林杜克島場址環境勘查工作行程與照片(續)

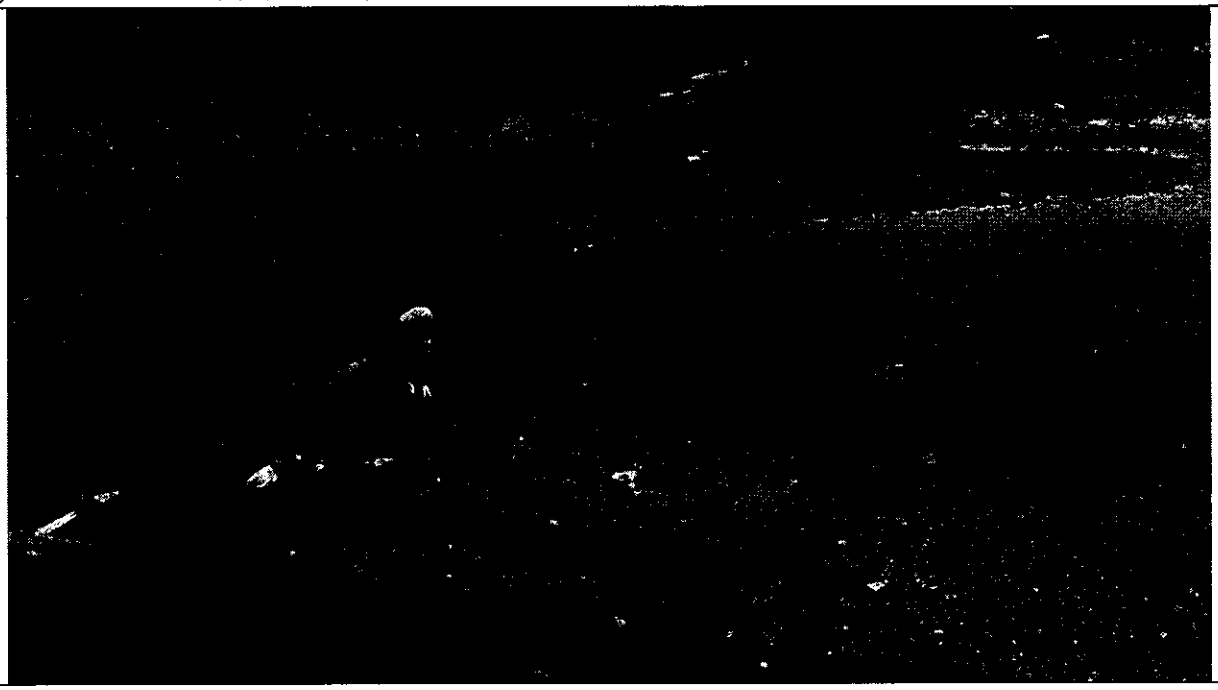
(g) MogPog river 現勘與採樣分析 – 上游

(h) MogPog river 現勘與採樣分析 – 上游

圖五、馬林杜克島場址環境勘查工作行程與照片(續)

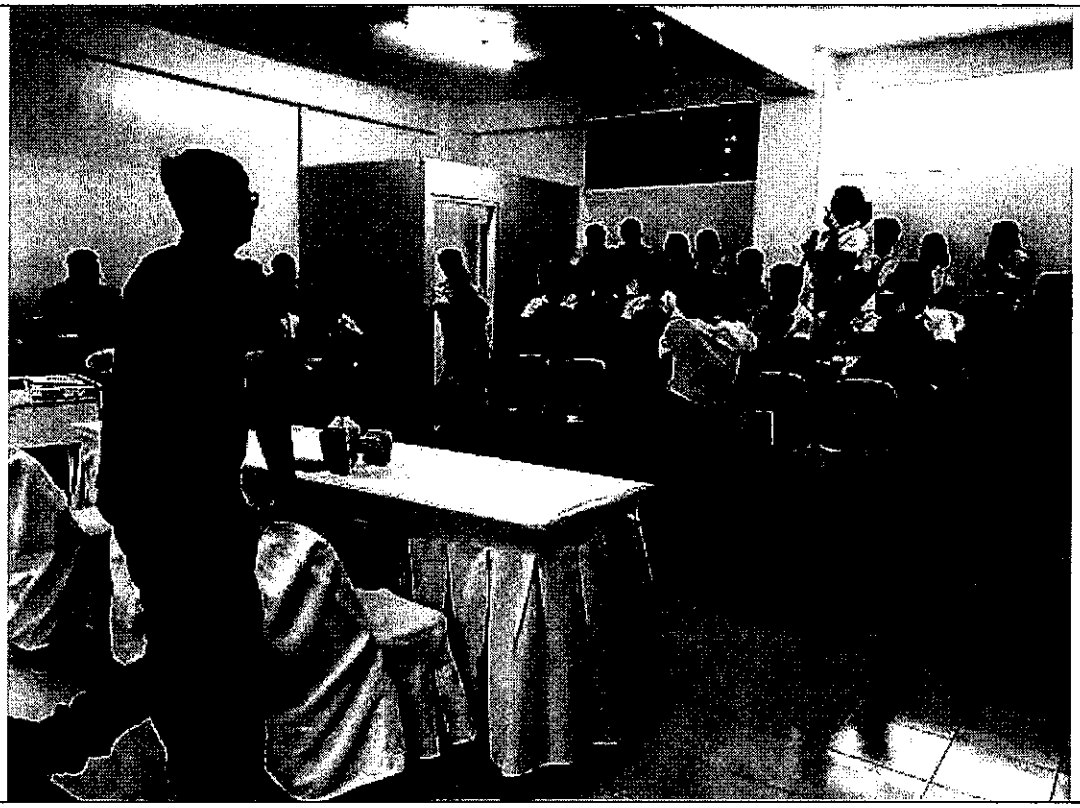
(i) MogPog river 現勘與採樣分析 – 下游

(j)Boac river 現勘與採樣分析 – 下游



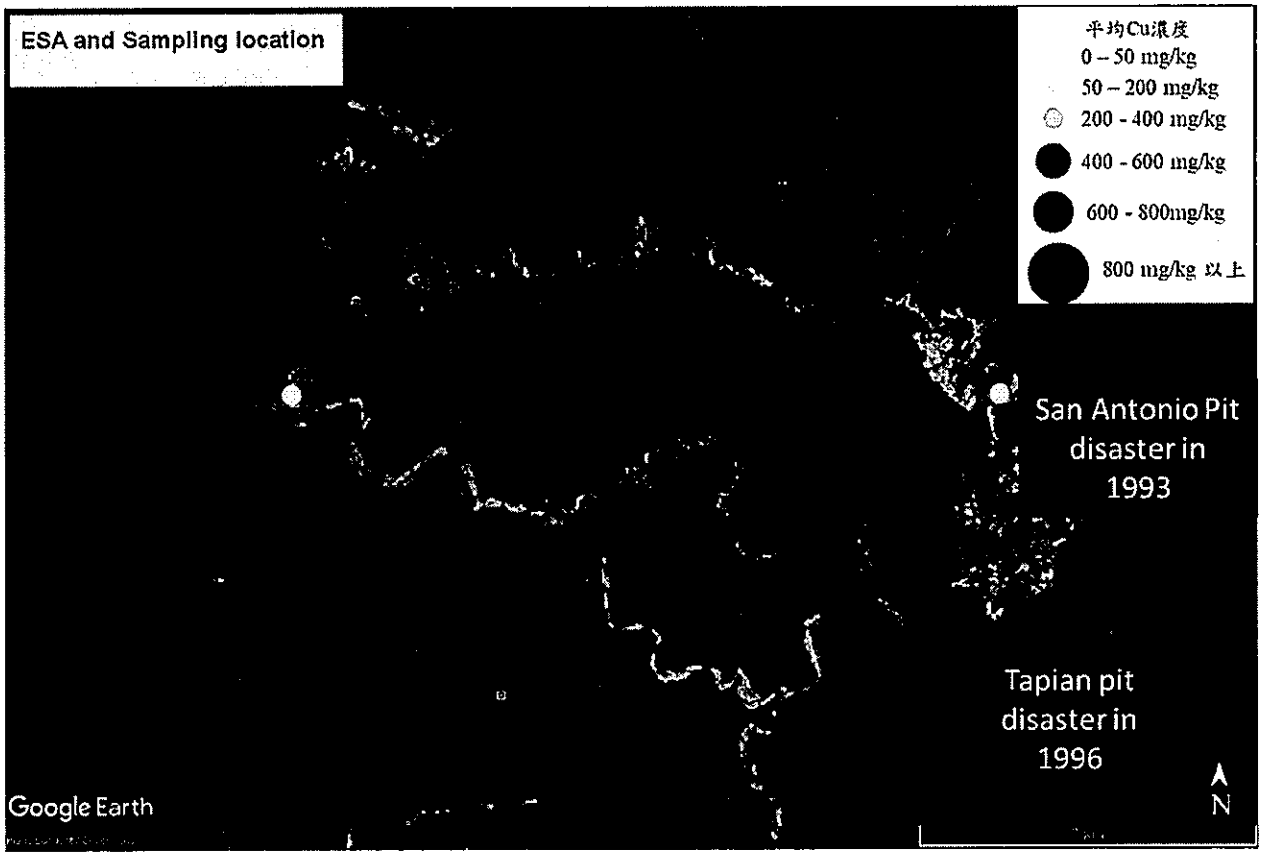
圖五、馬林杜克島場址環境勘查工作行程與照片(續)

(k) 馬林杜克學院演講與設備展示



(l) 馬林杜克學院校長拜訪

圖五、馬林杜克島場址環境勘查工作行程與照片(續)



圖六、Mogpog river 及 Boac river 流域底泥 XRF 篩測銅濃度分布

肆、心得及建議事項

近年杜特帝政府主政下，菲律賓開始重視環境污染問題，可預期菲律賓對於環境政策、技術與設備會有更多的需求，我國可組織環境領域的專家學者與廠商，透過策略規劃、技術輔導或設備展示等方式協助菲律賓發展環境治理策略，以推廣我國技術。惟受外交現況的限制，除透過官方管道的交流外，亦需透過學術單位與民間組織努力，在環保議題上與菲律賓政府與學術界爭取更多的合作空間。

菲律賓對於土壤及地下水污染的認知仍屬起步階段，目前尚無相對應的法規制度可依循，但菲律賓境內有 50 處以上的運作中/停止運作礦場存在重金屬或其他毒性物質污染問題；廢棄物非法棄置的狀況亦極為嚴重；在 1996 年起即已開始針對加油站設備設施進行更新，但仍缺乏土壤及地下水污染調查經驗，亦無預警監測措施。然菲律賓境內仍有許多人仰賴泉水或地下水做為日常生活水源，因此土壤及地下水污染議題將為下一階段潛在的環境問題。

本署透過「土壤及地下水污染整治工作國際合作計畫」，於菲律賓辦理土壤及地下水技術交流展示研習會獲得相當熱烈的迴響。由委辦團隊邀請國內專家學者赴馬林杜克島辦理場址環境勘查與評估工作，一方面訓練夥伴國家參與團隊進行場址勘查與環境評估，另一方面，透過技術示範的方式，協助進行場址調查工作，也讓國內學者與業者有展現技術能力的機會。期望未來可以持續透過國際合作計畫，整合政府資源與產、學技術能力，產生母雞帶小雞的效應，輔助我國環保產業向外拓展。

馬林杜克島場址環境勘查結果顯示，銅礦開採已嚴重影響 Mogpog river 與 Boac river 的上游與中游，部分河段底泥有高濃度銅沉澱物累積，顯示 2 個流域受到開採行為、1993 年與 1996 年的潰堤事件、酸礦水持續流入河川等因素影響，在地表水、地下水與河川底泥均持續造成污染，現勘時亦發現部份河道清淤過程同時進行河砂、礫石的掏選與開採，直接或間接對島上的居民健康與生態造成風險危害。然此類場址整治費用難以估計，但風險危害極高，未來應可透過臺、菲合作方式向國際開發銀行申請經費，辦理場址風險管理與流域治理工作。

總體而言，本次技術交流系列活動在臺菲環保工作交流上取得階段性的進展，未來應

持續推動雙方合作議題：

(1)從馬尼拉灣與河川流域治理、廢棄物管理與土壤及地下水污染整治著手，持續進行政策管理與技術經驗交流，以拓展本土廠商新南向市場機會。

(2)馬林杜克島的污染問題則可透過後續規劃調查改善計畫，以我國風險評估與管理經驗，延續本次評估成果，擴大交流內容與範疇，達成雙邊交流的目標。

Workshop on Water Quality Improvement for Drinking Water

March 07-08, 2019, Mapúa University, Manila, Philippines

March 07, 2019

Time	Topic
08:30 – 09:00	Registration
09:00 – 09:30	Opening and Presentation: The Taiwan-Philippines Joint Water Quality Research and Innovation Center in Mapúa Univesity Prof. Delia B. Senoro *Mapúa University*
09:30 – 10:10	Topic: Overview of Drinking Water Quality Research at National Cheng Kung University Prof. Tsair-Fuh Lin *National Cheng Kung University*
10:10 – 10:30	AM Break/Snack
10:30 – 11:15	Topic: Progress in Water Treatment, Purification and Quality for Domestic Supply Engr. Ronald Padua *Maynilad Water Services Inc.*
11:15 – 12:00	Topic: Progress in Water Treatment, Purification and Quality for Domestic Supply Dr. Danvir Mark Farnazo *Manila Water Company Inc.*
12:00 – 13:00	Lunch
13:00 – 13:50	Topic: Treatment of cyanotoxin and T&O compound in drinking water systems. Prof. Tsair-Fuh Lin *National Cheng Kung University*
13:50 – 14:40	Topic: Biological treatment of drinking water. Prof. Langmuir Whang *National Cheng Kung University*
15:10 – 15:30	Break/Snack
15:30 – 16:20	Topic: Taiwan Water Corporation: current status and future perspectives Dr. Tin-Lai Lee *Taiwan Water Corporation (TWC)*
16:20 – 17:00	Discussion / Q&A

March 08, 2019

Time	Topic
09:00 – 09:30	Topic: Challenges in water quality monitoring and treatment operations Ma. Evangeline Rey Mellano *St. Joseph Water Services Corporation*
09:30 – 10:20	Topic: Application of Molecular Biology Technique for Cyanobacteria in TiaHu Lake. Mr. Yi-Hsuan Chen *CENPRO Technology Co. Ltd.*
10:20 – 11:10	Topic: Monitoring of cyanotoxin and odorant-producing cyanobacteria in drinking water reservoirs using real-time PCR. Dr. Yi-Ting Chiu *National Cheng Kung University*
11:10 – 12:00	Discussion / Q&A
12:00 – 13:00	Lunch
13:00 – 15:00	Hands-on training: Cyanobacteria identification and enumeration Dr. Yi-Ting Chiu *National Cheng Kung University*
15:00 – 17:00	Hands-on training: Flavor Profile Analysis (FPA) Dr. Yi-Ting Chiu *National Cheng Kung University*

Workshop on Water Quality Improvement for Drinking Water

March 07-08, 2019, Mapúa University, Manila, Philippines

13:00 – 15:00 on March 08, 2019

Hands-on training: Cyanobacteria identification and enumeration	
13:00 – 13:30	Introduction of microscope and morphology of common algae. Using PowerPoint. Stay in the workshop room.
13:30 – 13:45	Move to the laboratory (microscope).
13:45 – 15:00	Identification and enumeration. Q & A.
Instruments and consumables: 1. Microscope with a monitoring screen.	

15:00 – 17:00 on March 08, 2019

Hands-on training: Flavor Profile Analysis (FPA)	
15:00 – 15:30	Introduction of flavor profile analysis. Using PowerPoint. Stay in the workshop room.
15:30 – 17:00	Started the FPA. Q & A.
Instruments and consumables: 1. Water bath @ 45°C. 2. Deionized water as much as possible.	

Water sampling activity at Laguna Lake

Mapua University and National Cheng Kung University

March 09-12, 2019

Date	Items
March 09, Saturday	1. Mobilization to Binangonan resort. 2. Preparation for sampling activity a. PE bottles (the bottles we left in May, so we don't need to buy that). b. The transformer which can transfer the voltage from 220V to 110V. c. Sampler. d. Lugol's solution. e. 1000 ppm Chlorine. f. 75% Ethanol. g. Deionized water.
March 10, Sunday	Sampling
March 11, Monday	Sampling
March 12, Tuesday	Transportation from Binangonan to Hotel.

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Progress in Water Treatment, Purification and Quality for Domestic Supply

Danvir Mark Farnazo
Water Forensics Head

March 07, 2019

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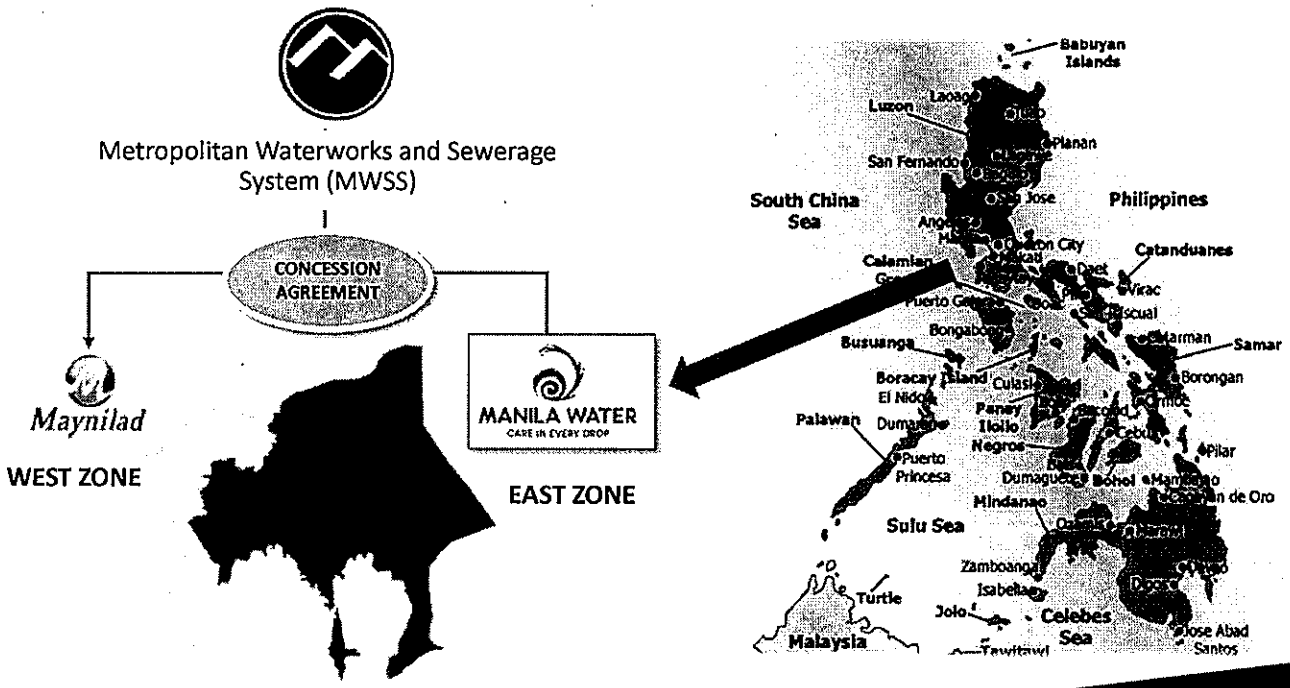
Manila Water Company



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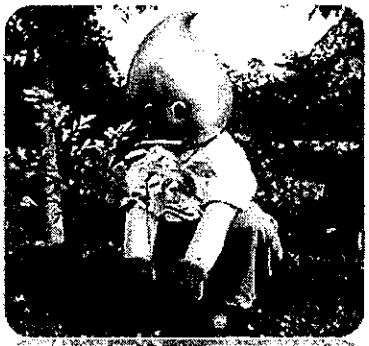
The Manila Water Vision

Our vision is to become a leader in the provision of water, used water and environmental services

Empower People



Protect the **Environment**

and **Enhance Sustainable Development**

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1,079,214
Billed connections across the enterprise

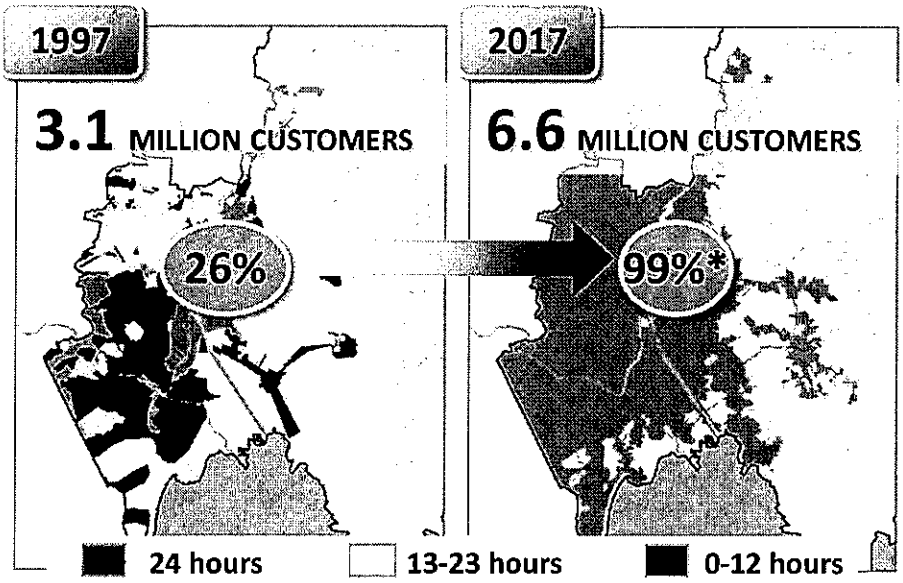
17.2M
Population served across the enterprise

107,994
Desludged septic tanks

141,266
Sewer connections

56.42 MCM
Used water treated

Improved Access to Piped-in Water



** Percentage of people reached by the network who have 24 hour water availability*

Manila Water made sure that leaks and pilferage were reduced, from 63% to the current 11%.

Water saved from efficiency measures were made available to new customers.

In the last 18 years, no new dam was built.

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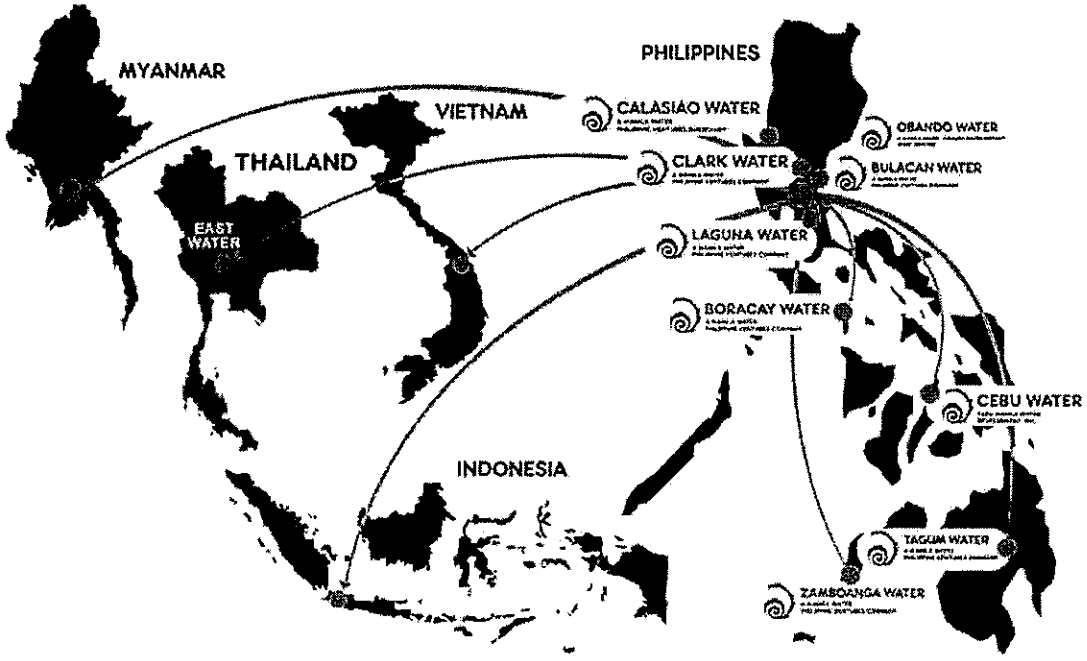

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Water Supply and Treatment Issues

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From Source to Treatment Plants

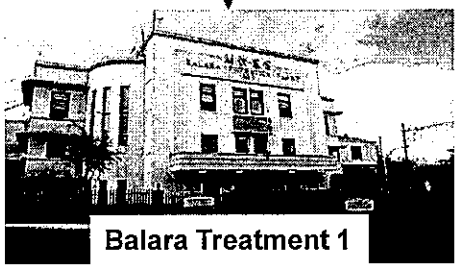
Transmission losses
= 50 - 80 MLD

Angat Dam

MWCI Allocation = 1600 MLD

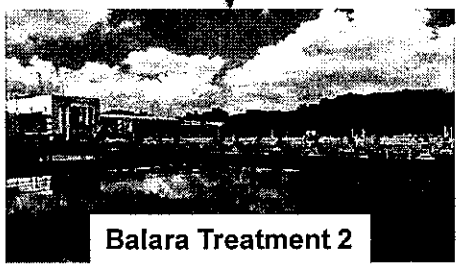
La Mesa Reservoir

Intake 1 & 2



Balara Treatment 1

Intake 3 & 2



Balara Treatment 2

Intake 4

East La Mesa Treatment Plant

Total Designed Production = 1560 to 1620 MLD (BTP 1 and 2) and 80 MLD from ELMTP

LAGUNA WATER
A MANILA WATER COMPANY

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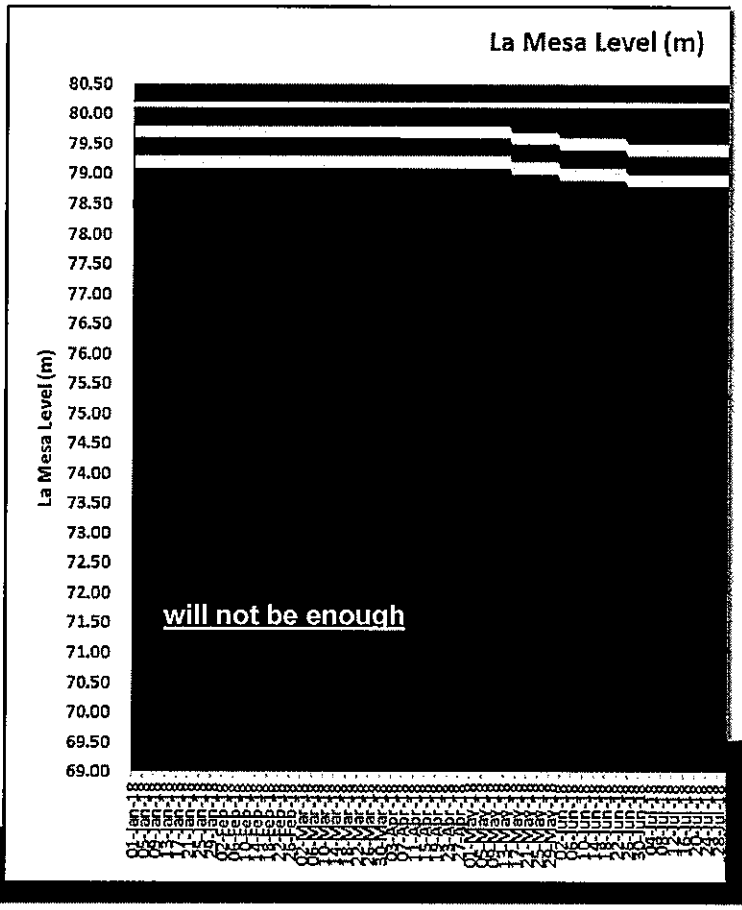
Challenges in Water Treatment

1. Raw water supply availability

- Billed volume expected to increase 50 MLD from 2017 onwards due to higher demand and expansion of services
- Transmission losses from Angat Dam is 50 – 80 MLD
- Production during summer exceeds the allocation, MWCI is now "harvesting" water from La Mesa Reservoir
- Decreasing level of La Mesa Reservoir

- WTPs are treating water above the design parameters
- Shortage in production due to poor water quality



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Challenges in Water Treatment

2. Low levels at intake structures in La Mesa Reservoir

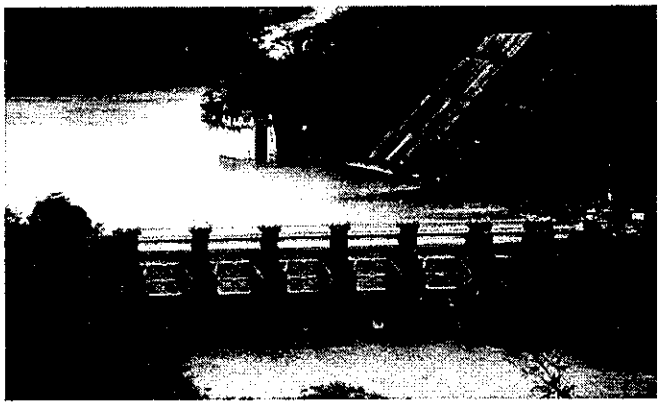
Exposed shores at La Mesa Reservoir

Problems encountered:

- Organic matters released from sediments from shallow water leads to higher chlorine demand during disinfection
- High turbidity due to run-off from exposed streambeds
- Highly colloidal, usual coagulant and flocculant are inefficient

Challenges in Water Treatment

3. Poor water quality from Ipo/Angat Dams



Ipo Dam at normal weather conditions

Ipo Dam during wet season

Cause:
- Sediment run-off from exposed soil due to deforestration

Problems encountered:
- High turbidity (<600 NTU)
- High sediment content (reduced storage capacity of La Mesa Reservoir)
- High organic content may lead to higher chlorine demand during

Short-term Strategies
- Raw water abstraction management via bypass and various headworks projects
- La Mesa reservoir water quality profiling
- Operational and process adjustments in WTPs

Long-term Strategies
- Installation of Ecotone vegetative filter at the shores of La Mesa Reservoir
- Intensive watershed protection
- Laguna De Bay as Raw Water Source
- Improved water source and treated water WQ monitoring
- Comprehensive process profiling of WTPs

Water treatment plant operation and process adjustment

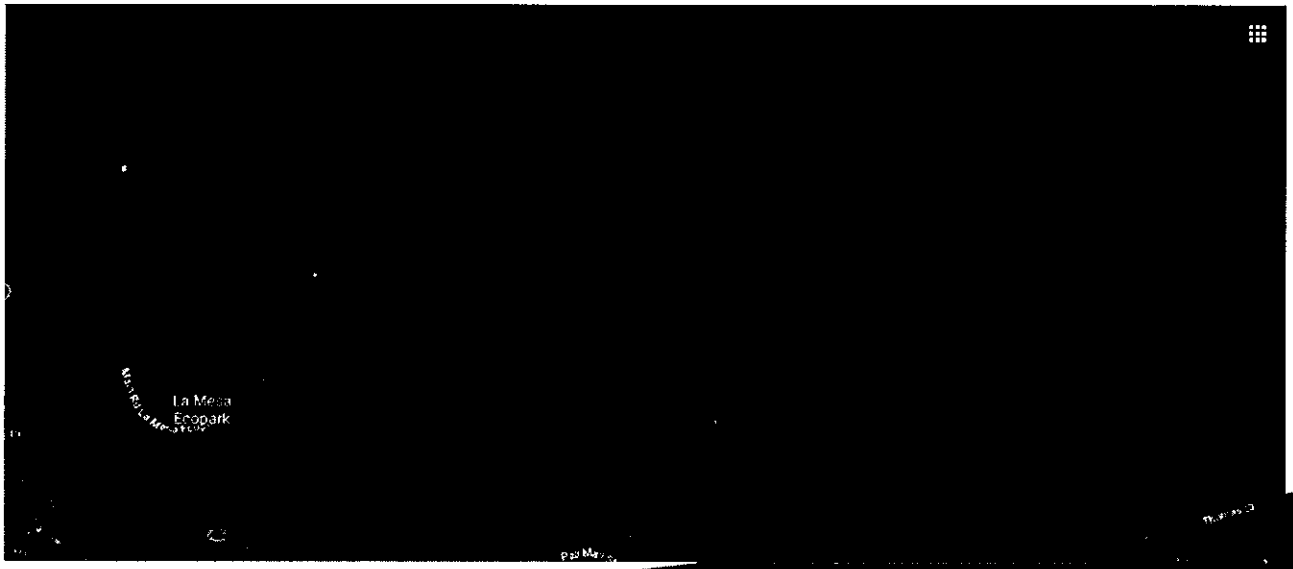
1. Reduce production to assist WTP in treating high turbidity during low water level and heavy rainfall
2. Switching from alum sulfate to poly-aluminium chloride (PAC) as coagulant when turbidity is high
3. Use of anionic coagulant when raw water is highly colloidal
4. Increase chlorine dosing to attenuate effects of organic compounds whilst maintaining 1.5 ppm residual chlorine at the treated water

Investigations

1. La Mesa Reservoir Water Quality Profiling

Objectives:

1. Investigate the effect of low levels at Intakes 1 -4 to water qualities
2. Determine treatment options to address poor water quality



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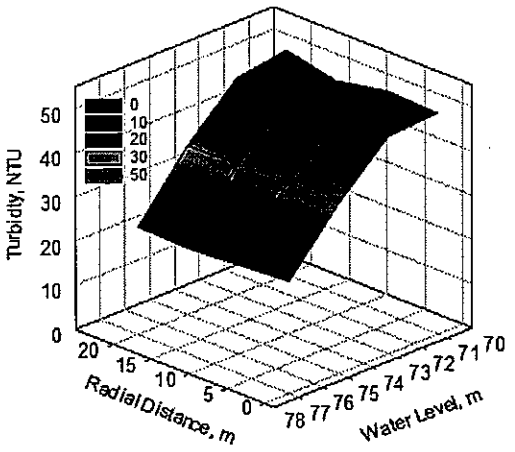
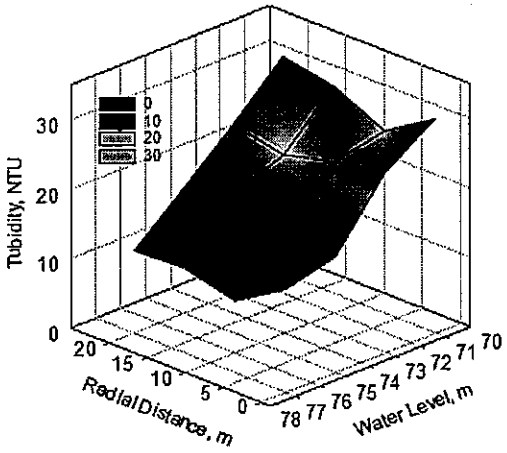
Investigations

La Mesa Reservoir Water Quality Profiling



Intake 1 & 3
(Balara Treatment Plant 1)



Intake 2
(Balara Treatment Plant 2)

- For Intake 1 & 3 , increasing turbidity with decreasing water level
- For Intake 2, low turbidity levels were observed demonstrating the effectiveness of the turbidity

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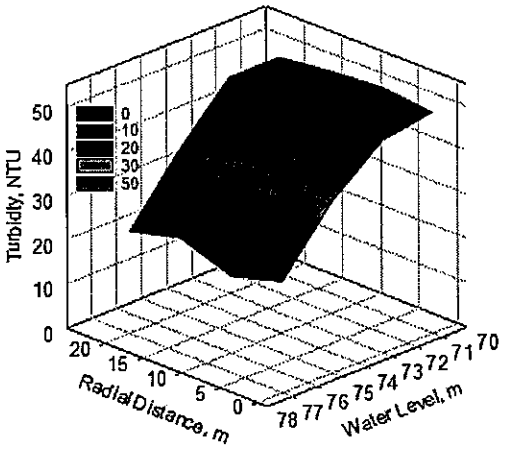
Investigations

La Mesa Reservoir Water Quality Profiling



Intake 4
(East La Mesa Treatment Plant)

- Although increasing turbidity with respect to water level is observed, turbidity is decreasing with radial distance

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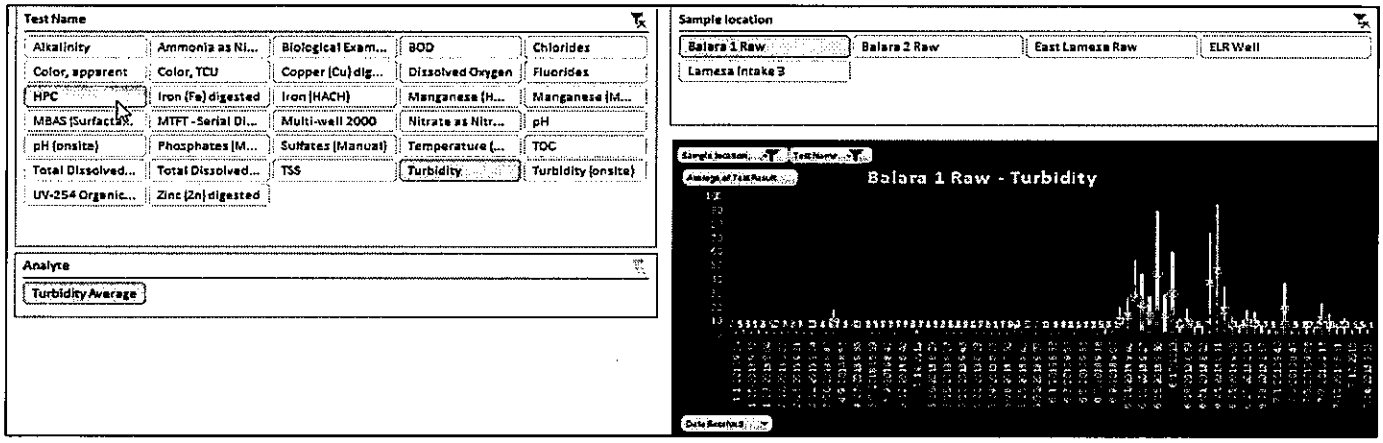
Improved Water Source WQ Monitoring

OBJECTIVES/OUTPUT	• Monitor diurnal WQ parameters at La Mesa Reservoir and Laguna Lake intakes • Provide early warning to Water Supply Operations for consequent process adjustments and augmentation to ensure water security and quality



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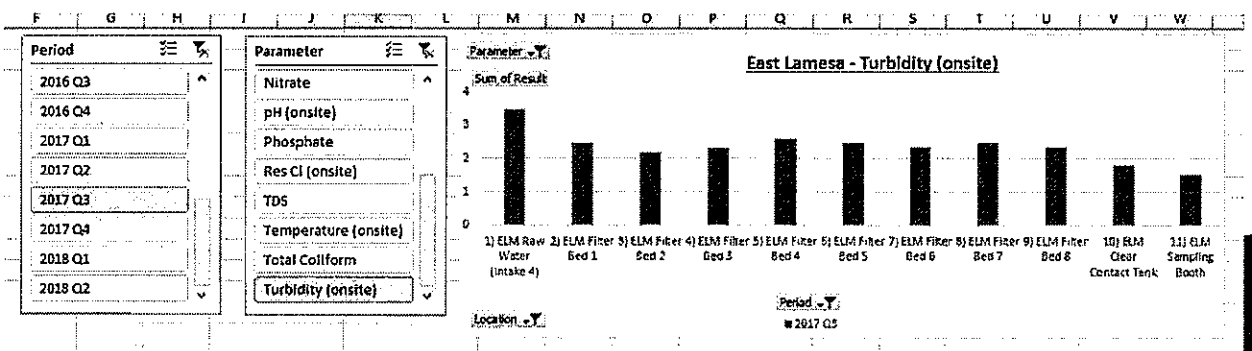
Robust WTP Profiling

OBJECTIVES/OUTPUT	• Provide insight of WTP unit process efficiencies • Close monitoring of operational and process adjustments employed to address incident-related non-conformances • To monitor new technologies in water treatment facilities

Process units monitored:

- Coagulation
- Flocculation
- Sedimentation
- Filter Beds
- Clear Tank (if applicable)
- Sampling Booths



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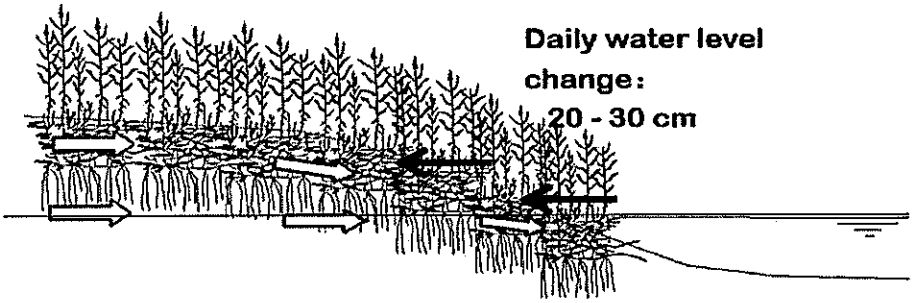
On-going Projects: Biomanipulation of Source

1. Installation of Buffer Zones at Reservoir

Enhance self-purification ability of water source via ecotone vegetative filter

Change of water level:
To let O_2 penetrating into reed beds and enhance water and matrix interaction



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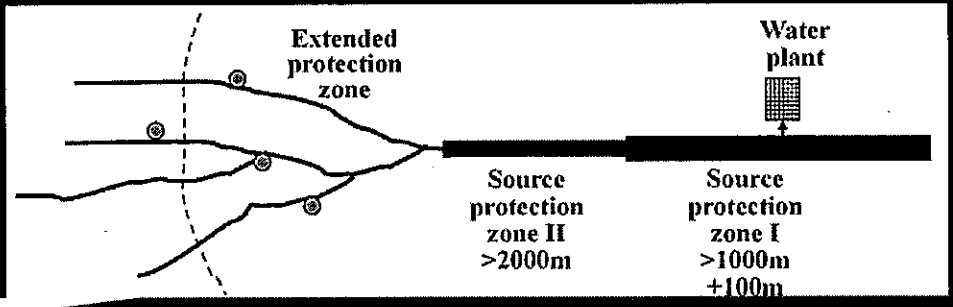
On-going Projects – Biomanipulation of Source

2. Watershed Management

Planning of source water protection zones

- In source protection zone I, facilities with no relation to water supply is not allowed, those exiting facilities have to be removed or destroyed. Tourism, fishing, swimming and other potential pollution activities are forbidden.
- In zone II, pollution facilities is not allowed, those exiting facilities have to be removed or destroyed. Tourism, fishing, swimming and other potential pollution activities have to be controlled with severe inspect.



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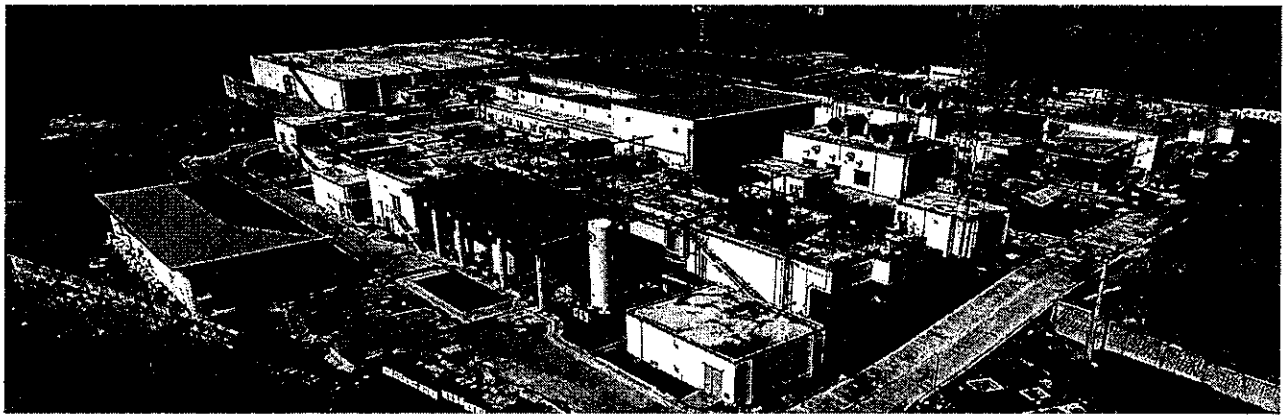
Laguna De Bay as Raw Water Source

Rizal Province Water Supply Improvement Project



PHASE 1: 50 MLD (April 2019)
PHASE 2: 50 MLD (June 2019)

Features innovative treatment suited for treatment of Laguna de Bay's brackish water

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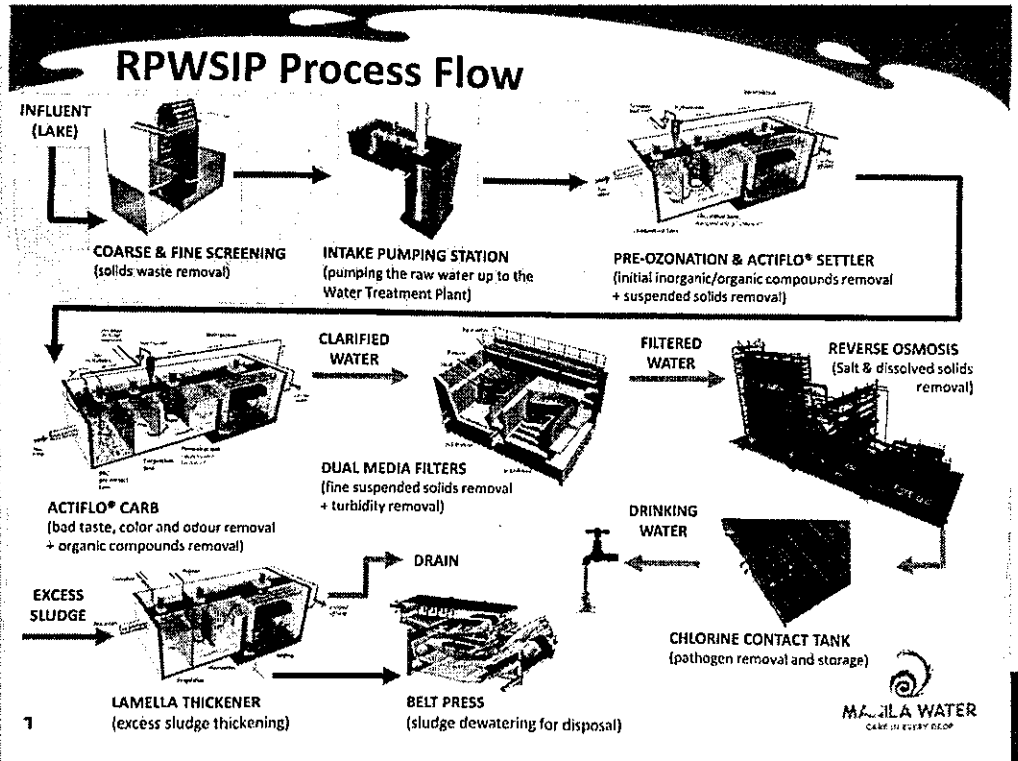
RPWSIP Innovative Process Design



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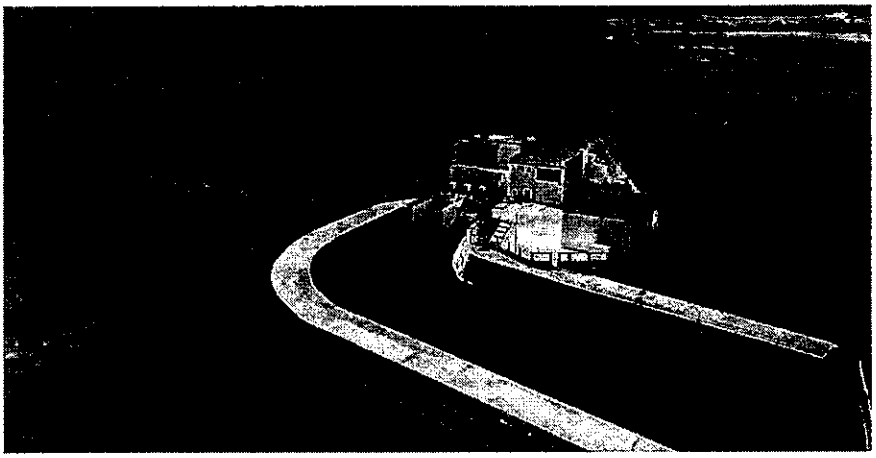
Challenges in Laguna de Bay raw water treatment

Macrophytes Bloom and Potential Microalgae Proliferation



Foreseen problems:

- Rapid propagation of water hyacinth at the RP WTP Intake posing clogging and inefficient abstraction of raw water
- Human activities in the vicinity of the WTP and intake structure may cause lake eutrophication
- Microalgae and cyanobacteria proliferation due to eutrophication leading to release of T&O compounds and trace level toxins

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Conclusion

- **Manila Water is dedicated to providing clean and sustainable water and sanitation to all our consumers while fulfilling our obligations to MWSS and regulators.**
- **Water quality and environmental protection dictates innovations, research and operations of Manila Water.**
- **Manila Water is in need people who can help us achieve our commitment to achieving Sustainable Development Goals.**
- **Manila Water is encouraging collaborative research works with the academe, regulators and stakeholders wherein our interests are both protected and served.**

Fernando Zobel de Ayala
Chairman
Manila Water Company

Soil and Groundwater Protection

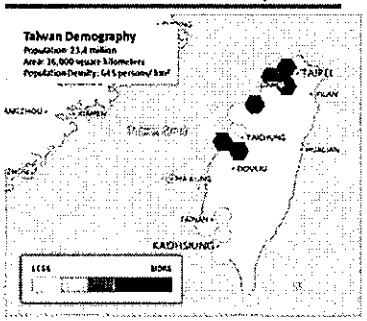
The prospect of cooperation in near future

0

Soil and Groundwater Pollution Remediation Fund, Taiwan EPA

- Established in Feb 2, 2000 based on Soil and Groundwater Pollution Remediation Act
- Missions
  - Manage the soil and groundwater resources in Taiwan
    - Quality control and management of soil, groundwater and sediment
    - Contamination site identification and management
    - The Soil and groundwater pollution remediation fund management
  - Support the soil and groundwater related technology development and knowledge spread

Taiwan Soil and Groundwater Pollution Map



Control sites

Number : 3,180

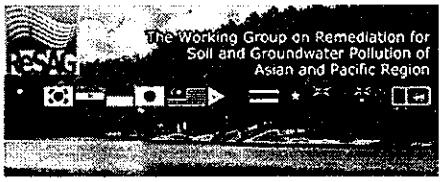
Control sites relieved from announced control list

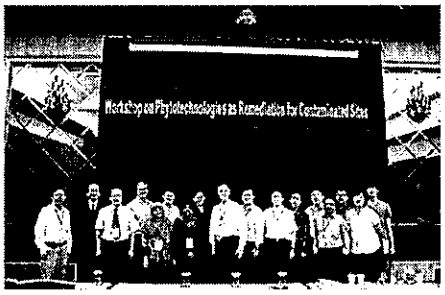
Number : 4,706

1

International cooperation project of Soil and Groundwater protection

- Formed Working Group on Remediation for Soil and Groundwater Pollution of Asian and Pacific Region (ReSAG) in 2010
- International conference in Taipei
- Annual workshops and training courses for ReSAG members
- International cooperation project in 2018
  - Workshops in of ReSAG member countries
  - Invite professors and experts to conduct phase I assessment in ReSAG member countries





2

International cooperation project in 2018

- Workshop on Soil and Groundwater Contamination Site Assessment and Remediation

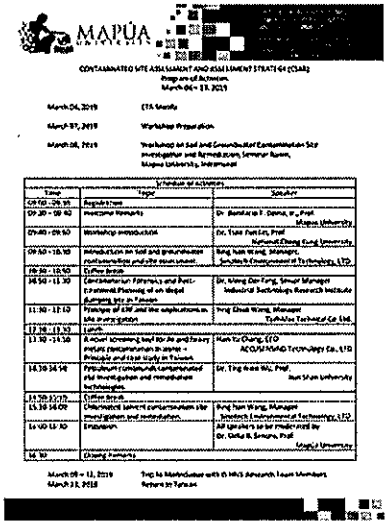
MAPÚA UNIVERSITY

Kun Shan University 科技大學

ACCUSENSING

工業技術研究院 Industrial Technology Research Institute

Johas



- Site Assessment of Mogpog river in Marinduque Island

3

The prospect of cooperation in near future

- **Strengthen the official collaboration on environmental protection between the Philippines and Taiwan**
  - Facilitate the Signing of an MOA/MOU on environmental protection
- **Strengthen the official collaboration on soil and groundwater protection and remediation**
  - For safe drinking water and food corps
  - MOU on Soil and Groundwater Protection and Remediation
- **Recommend Steering Committee Member and contact personal of ReSAG working group**
  - For long term cooperation

4

Thank you

5

March, 8, 2019

2019 Taiwan – Philippines Workshop on

Soil and Groundwater Contamination Site Investigation and Remediation

Mapúa University, Manila, Philippines

Proceedings

2019 Taiwan – Philippines Workshop on
Soil and Groundwater Contamination Site Investigation and Remediation

Program

Date : 8th, March, 2019

Venue : Mapúa University, Manila, Philuppines

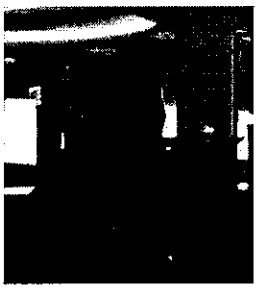
Time	Topic	Speaker
09:00 - 09:30	Registration	
09:30 - 09:40	Opening Address	Dr. Bonifacio T. Doma, Jr., Prof. Mapúa University Dr. Chien-Jen Ho Taiwan EPA Prof. Tsair Fuh Lin National Cheng Kung University
09:40 - 10:20	Introduction on Soil and groundwater contamination and site assessment	Bing-Nan Wang, Manager, Sinotech Environmental Technology, LTD.
10:20 - 10:50	Coffee break	
10:50 - 11:30	Contamination Forensics and Post-treatment Planning of an illegal dumping site in Taiwan	Dr. Meng-Der Fang, Senior Manager Industrial Technology Research Institute.
11:30 - 12:10	Experience of rapid heavy metal elemental analysis by XRF in Taiwan	Ying-Chun Wang, Manager JOHAS Technical Co. Ltd
12:10 - 13:30	Lunch	
13:30 - 14:10	A novel screening tool for As and heavy metals contamination in water – A case study in Taiwan.	Hans Chang, CEO ACCUSENSING Technology Co., LTD
14:10-14:50	Petroleum compounds contaminated site investigation and remediation technologies.	Prof. Ting-Nien Wu, Kun Shan University
14:50-15:10	Coffee break	
15:10-16:00	Chlorinated solvent contamination site investigation and remediation.	Bing Nan Wang, Manager Sinotech Environmental Technology, LTD.
16:00-16:30	Discussion and Q/A	All speakers to be moderated by Dr. Delia B. Senoro, Prof Mapúa University
16:30	Closing Remarks	

2019 Taiwan – Philippines Workshop on Soil and Groundwater Contamination Site Investigation and Remediation | **March 8 2019**

Contents

2019 Taiwan – Philippines Workshop on
Soil and Groundwater Contamination Site Investigation and Remediation

Speakers Introduction



Dr. Ting-Nien Wu

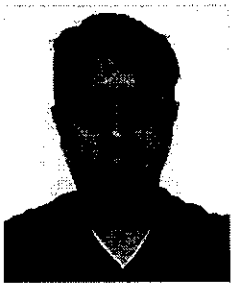
Professor
Kun Shan Universit.

Prof. Wu got his Ph D from Texas A&M University (U.S.A.) in 1994 and majored in environmental engineering. He is presently a professor of Department of Environmental Engineering of Kun Shan University, Tainan, Taiwan. Prof. Wu is an environmental expert specialized in site assessment and contaminant control in air, soil and groundwater. In the past 20 years, Prof. Wu implemented and supervised more than 50 funding projects regarding air pollution control, river basin management, soil / groundwater pollution cleanup and environmental monitoring in Taiwan. He published more than 30 journal papers and 30 international conference papers and also owned 6 patents regarding groundwater remediation technologies.

Dr. Meng-Der Fang

Senior Manager
Industrial Technology Research Institute

Dr. Fang received his Ph D from National Sun Yat-sen University (Taiwan) in 2007 and majored in Marine Environment and Engineering. He is currently the manager of Micropollutant Analysis Department in Industrial Technology Research Institute, Hsinchu, Taiwan. Dr. Fang is specialized in chemical analysis and environmental forensics. In his career, he has published 25 SCI journal papers and supervised or co-supervised more than 10 large projects from Taiwan EPA for implementing their policy. He also won the Outstanding Project Manager Prize of the year from Taiwan Association of Soil and Groundwater Environmental Protection in 2015.



Ying-Chun Wang

Manager
JOHAS Technical Co. Ltd

Mr. Ying-Chun, Wang has been working in the XRF analysis industry for almost decade. He has several application experiences in different industries, such as PCB, Semiconductor, environmental, recycling etc. Mr. Wang has cooperated with SGS, AECOM to help them rapid heavy mental elements in soil, groundwater or waste by XRF in Taiwan and China. Based on different pollution source, he knows how to use the unit making the analysis faster and accuracy. Therefore, he has sold many units in environmental industry and offer the efficiency process.

2019 Taiwan – Philippines Workshop on
Soil and Groundwater Contamination Site Investigation and Remediation

Speakers Introduction

Bing-Nan Wang

Manager

Sinotech Environmental Technology, LTD.

Mr. Bing-Nan Wang was trained in environmental engineering and got master degree from National Chung Hsing University. He attained Department of Environmental Engineering, National Cheng Kung University in 2017 to pursue the ph. D degree. In 2000, Mr. Wang joined Sinotech Environmental Technology, LTD and worked on soil and groundwater investigation and remediation. Mr. Wang implemented several site assessment project founded by Taiwan EPA including military bases, air ports, petroleum chemical industries and gas station. Mr. Wang also held several DNAPL bioremediation project in Taiwan and successfully cleaned-up a TCE groundwater contaminated site. He won the Outstanding Engineering Prize of the year of Taiwan Association of Soil and Groundwater Environmental Protection in 2017.

Han-Yu Chang

CEO

ACCUSENSING Technology Co., LTD

Mr. Hans Chang graduated from National Chung Hsing University and majored in soil science and electrochemistry. Mr. Chang has 10 years working experience of soil and groundwater investigation and remediation and participated several site assessment projects founded by Taiwan EPA including military bases, abandoned factories and gas stations. Mr. Chang is the founder of ACCUSENSING Technology Co., LTD. ACCUSENSING takes electrochemistry as core technology and be capable of R&D and manufacturing. ACCUSENSING expect providing substantial benefit to environment by developing fast and accurate environmental monitoring devices to improve the time required to obtain pollution information.

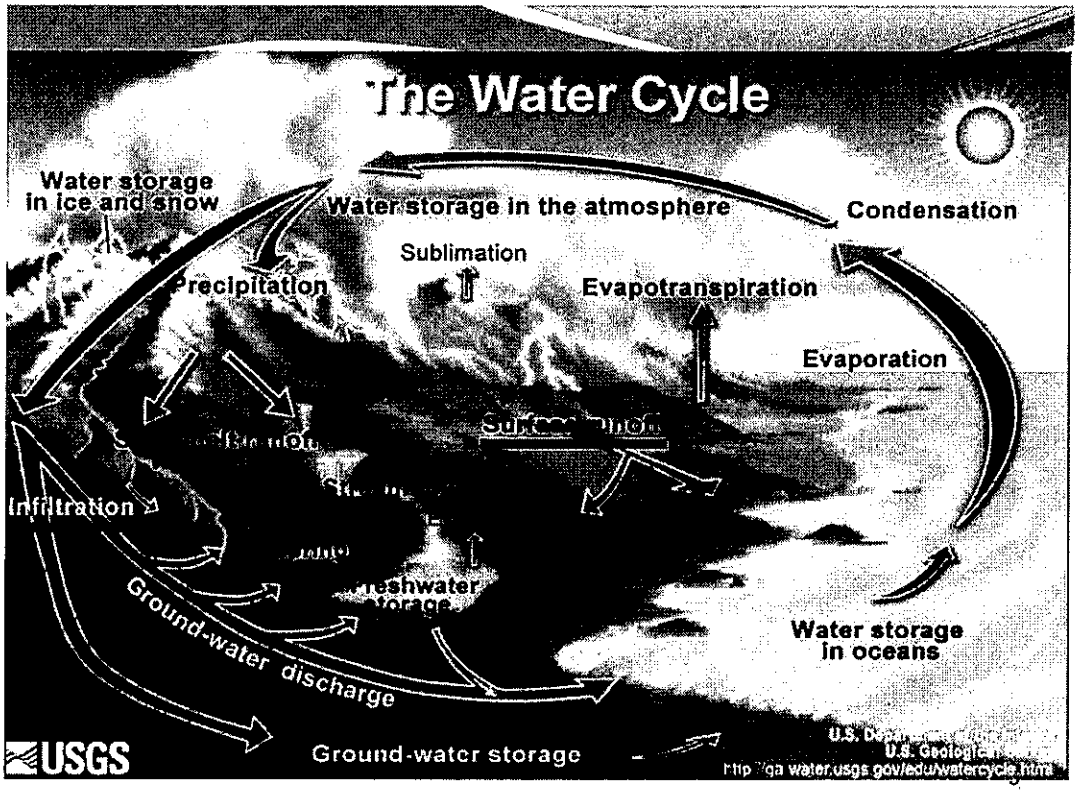
2019 Taiwan – Philippines
Workshop on Soil and Groundwater Contamination Site Investigation and Remediation

Introduction on Soil and Groundwater Contamination and Site Assessment

Bing Nan Wang, Manager
Sinotech Environmental Technology, LTD.
2019.03.08

Outline

- Soil and groundwater contamination
- Site Assessment and Site investigation
- Site Assessment and Cases
- Site Investigation and Cases
- Conclusions



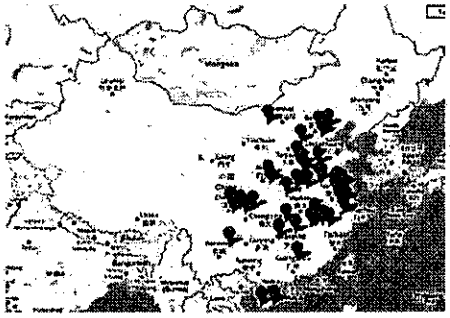
Soil and groundwater contamination

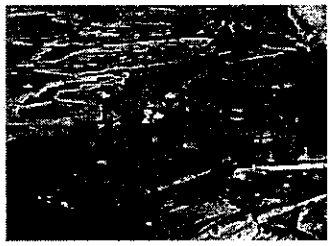
- Soil, Groundwater or Sediment are the final destination of anthropogenic pollutants.
- Soil/Groundwater/Sediment Pollution
  - Substances, biological organisms or forms of energy introduce into Soil/Groundwater/Sediment that alters the quality, impacts the normal use or endangers public health and the living environment

from Taiwan Soil and Groundwater Pollution Remediation Act, 2011

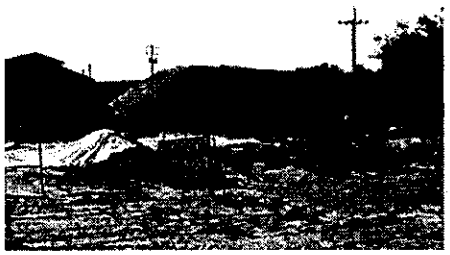
Soil and groundwater contamination

- Most are invisible from ground surface.
  - Be noticed only when the pollution is serious or some people die or sick because of the contamination.
- Large surface area/pore volumes
  - Large capacity/amount of pollutants hide under ground surface
- Slow interactions (with air and water)

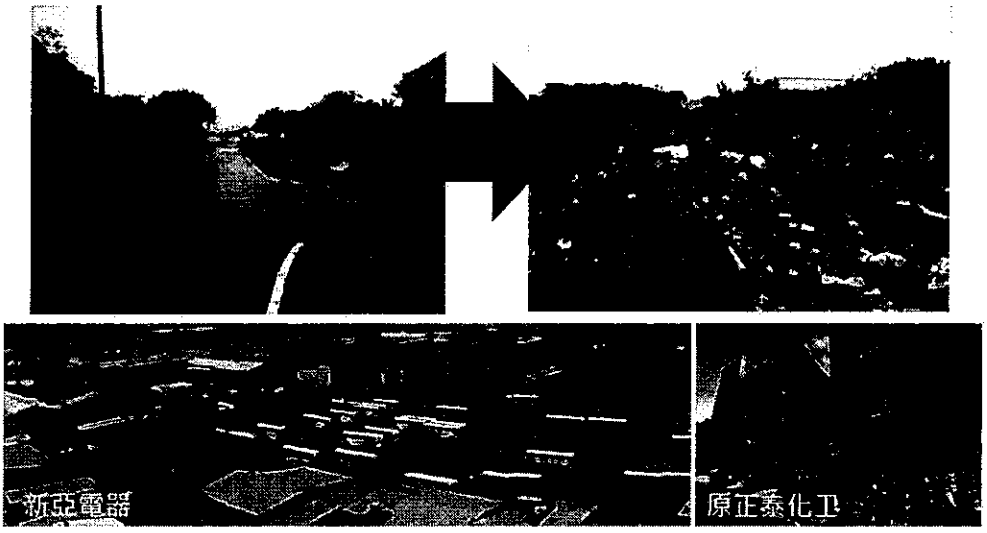




Soil and groundwater contamination

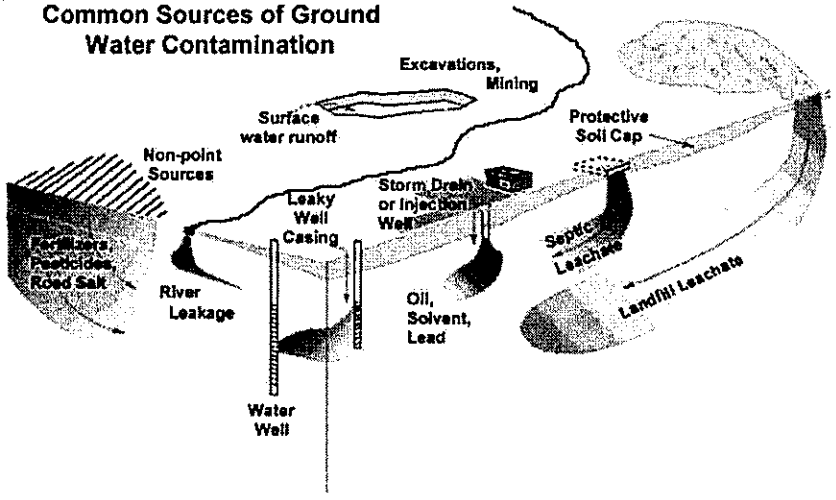


Soil and groundwater contamination



Soil and groundwater contamination

- Sources of the soil and groundwater contamination



Soil and groundwater contamination

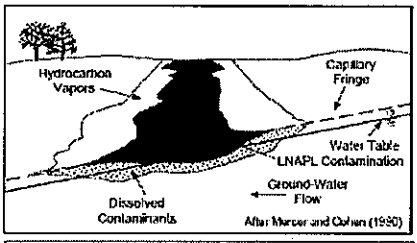
- Sources of the soil and groundwater contamination
  - Improper discharge of industrial wastewater and storage of waste
  - Leaked storage tanks and pipelines
    - Gas station
    - Factories, Petroleum Chemical Industries
  - Illegal dumping
  - Improper management of (sanitary) landfills
  - Air Pollution
    - Acid deposition
    - Leaded gasoline emission
    - Heavy metal fume emission
  - Agriculture/ Septic tanks
    - Pesticides
    - Fertilizers
    - Animal wastes
    - Nitrate
  - Accidents
  - Mining

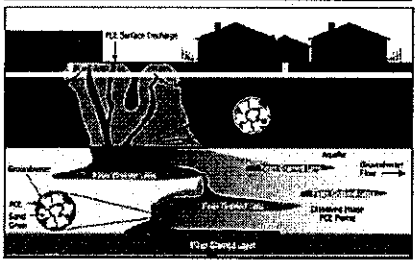
Soil and groundwater contamination

- Inorganic contamination
  - Heavy metals
    - Pb, Zn, Cu, Hg, Cr, Cd, As, and Ni
    - Manufacturing, Metal plating, Plastic Industries, Mining
    - Mostly positive charge, adsorbed to soil
    - Low mobility, near 30 cm of ground surface
    - As and Cr are redox sensitive chemicals
    - Affected by CEC of soil
    - Some are naturally occurring e.g. As
    - Some come from new industry e.g. Y, In, Mo
  - Ions
    - Cl^-, NO_3^-, NO_2^-, SO_4^{2-}, PO_4^{3-}, F^-, NH_4^+
    - Ions are soluble in water and spread and transport with the groundwater .
    - Agriculture and human activities

Soil and groundwater contamination

- Organic contamination
  - Petroleum HCs
    - TPH, Benzene, toluene, ethyl benzene, xylenes (BTEX), MTBE
    - Light Non-aqueous Phase Liquid (LNAPL)
    - Major sources: gasoline and diesel
  - Chlorinated HCs
    - Dense NAPL (DNAPL)
    - Dry Cleaning, electronics, metal degreasing
  - Others
    - Pentachlorophenols, phenols, dioxins, pesticides, herbicides
- Volatile, soluble, biodegradable
- In unsaturated zone: vertical migration
- Saturated zone: vertical and horizontal migration
- Affected by SOM





Site Assessment and Site investigation

- Purposes of Site Assessment and Investigation
  - For human and ecosystem health and safety
    - Baseline survey
    - Environmental Safety Assessment of potential sites
    - Monitoring
    - Early warning system
    - Environmental forensics
  - For Property transaction
    - Self-Investigation
    - Ownership Transfer of Land
    - Closure of Factories
    - Site Selection of New Factories
  - For Remediation
    - Delineation of the pollution and the boundary
    - Remedial investigation and feasibility study, RI/FS
    - Remedial action
    - Validation after remediation

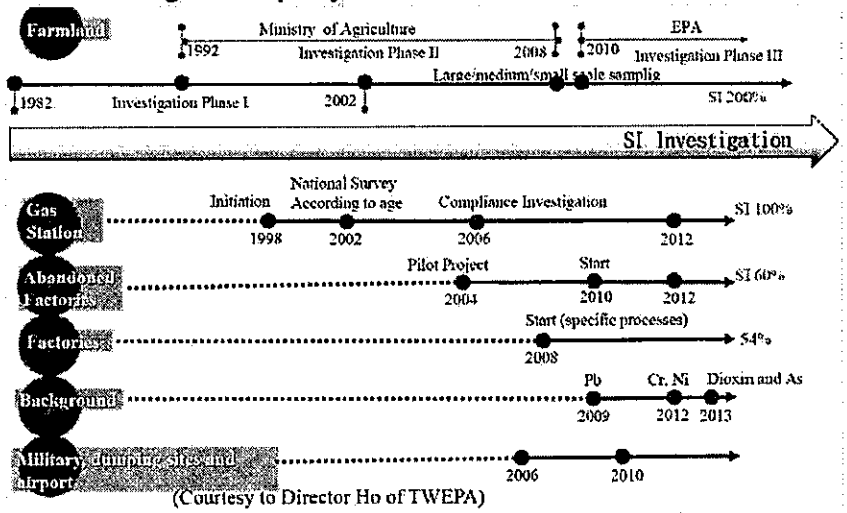
EPA or Local EPB Or Authorities

Land/ Factory owners

Polluters/ Stake holders

Site Assessment and Site investigation

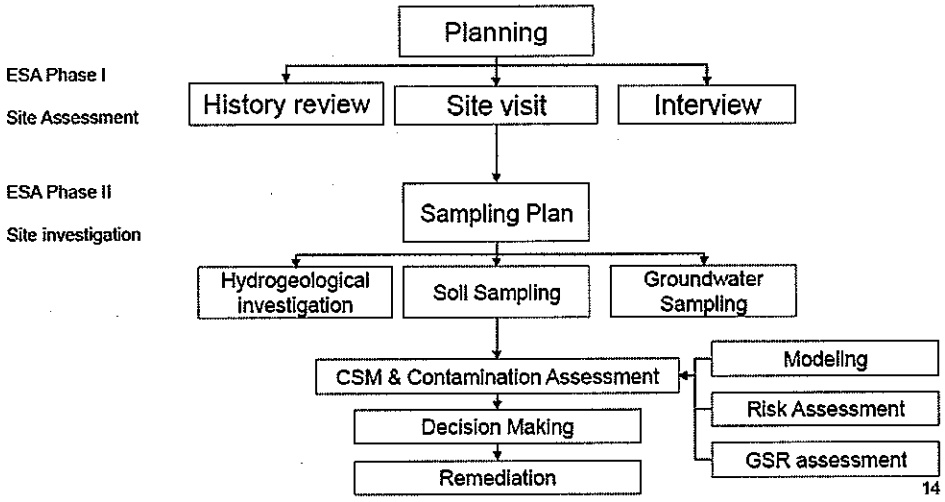
- Site investigation projects in Taiwan



(Courtesy to Director Ho of TWEPA)

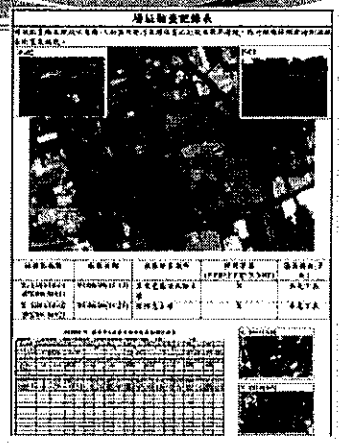
Site Assessment and Site investigation

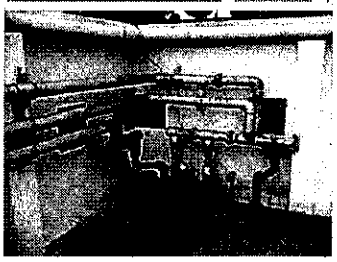
- Process of Site Assessment and Site investigation



Site Assessment

- Identify Objectives
  - Collect background Information
  - Identify the potential contamination, pathway and acceptors
  - Preliminary risk identification
  - Preliminary conceptual site model
  - Important factor for data collection and further sampling plan
- In general, no heavy machines are required, but may involve simple instruments
  - Site Visit/Survey
  - Interview

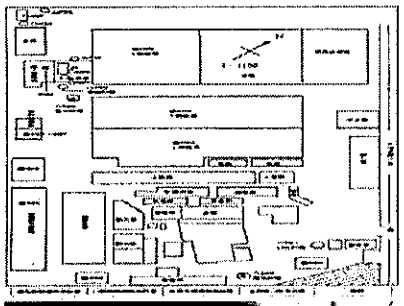


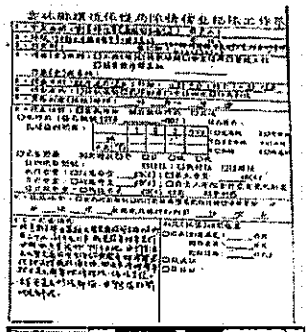


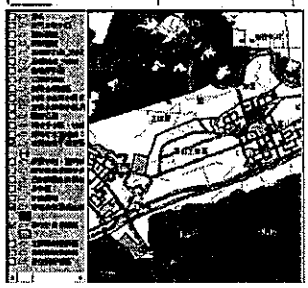
Site Assessment

- Background Information of the site
  - Historical records and activities on the site
  - Surroundings
  - Site Maps
    - Factory configuration
    - Manufacture process and configuration
    - Pipeline (water, wastewater, natural gas, electricity, internet ect.)
  - Aerial photos
  - Maps for land usage
  - Chemical usage records (including MSDS, historical records)
- Natural Environment information
  - Soil
  - Geological information and drilling data
  - Topographical data
  - Meteorological data
  - Groundwater
  - Surface water

Site Assessment







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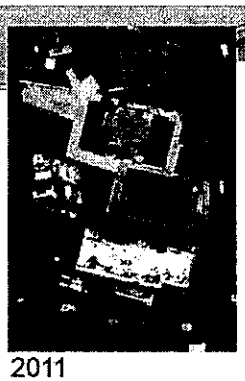
Site Assessment

- Site History
- Manufacturing Records, Chemicals Used, Registrations, Maps



2011

1976

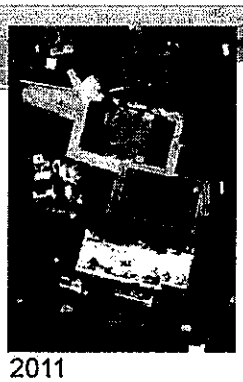
1988

1990

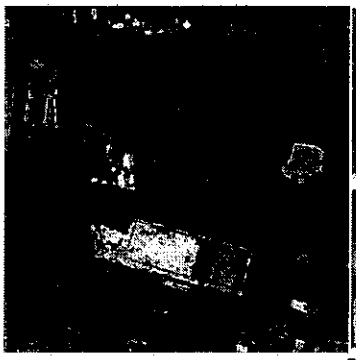
18

Site Assessment

- Historical Aerial photos
  - The transition/evolution of land use



2011



1993

2007

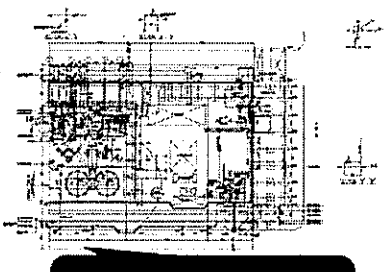
2009

19

Site Assessment

- Site visit and observation
  - The pipeline/trench configuration is important
    - Leaking point under ground
    - Potential transportation pathway of the leaking liquids
    - Safety and risks

Sump or underground tank connect to the pump and pipes are major leaking sites



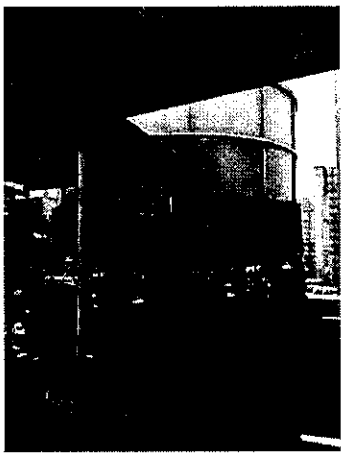
There may have 2 or 3 layer of pipes underground

20

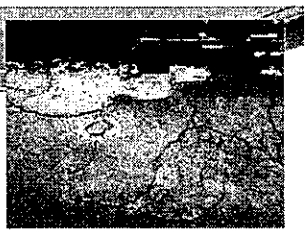
Site Assessment

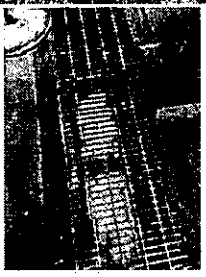
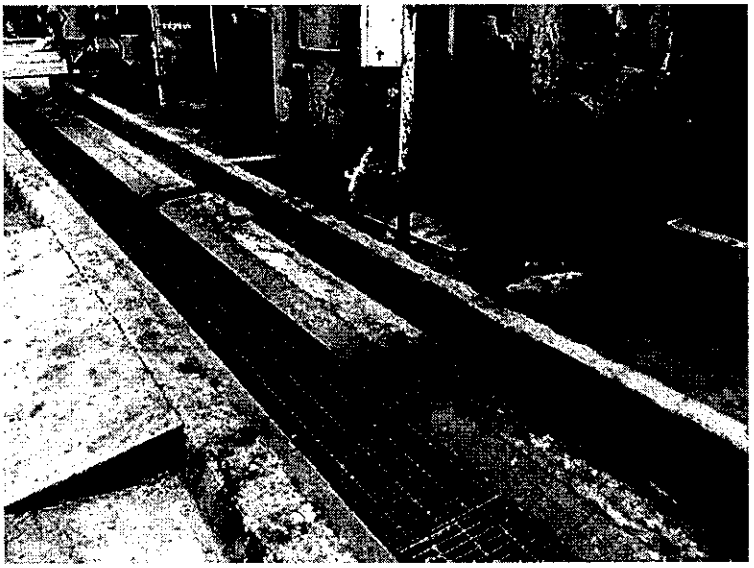
- Site visit and observation
  - Wet manufacturing process and ditches/sumps
    - Improper operation can be observed
    - Trench and sumps nearby
    - The temporary storage area





Site Assessment



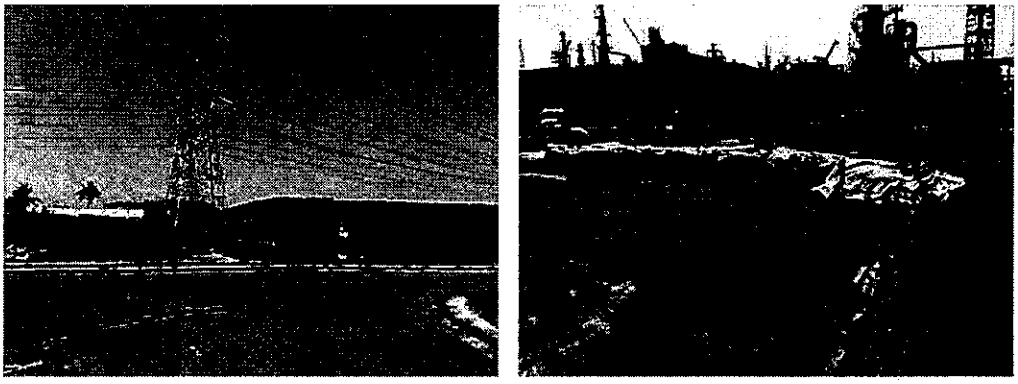



Site Assessment

- Wastewater treatment plant

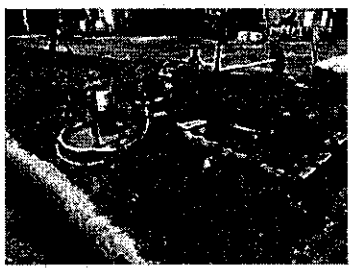
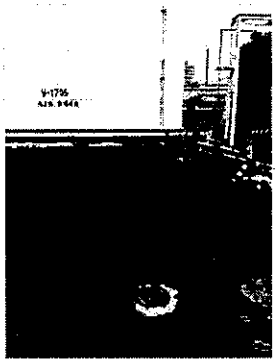
Site Assessment

- Raw material and wastes storage area



Site Assessment

- Other evidence related to soil and groundwater in the sites

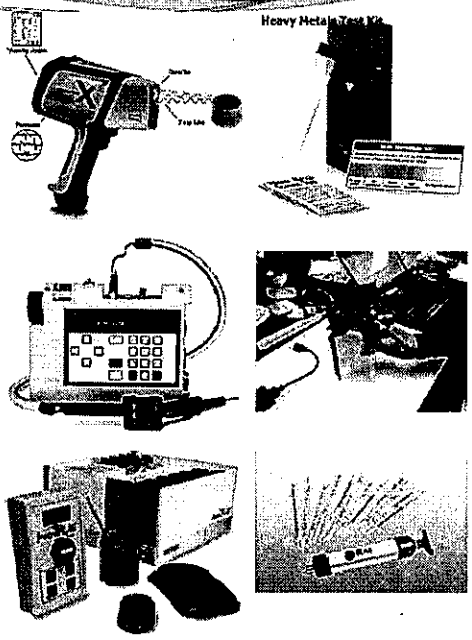





Site Assessment

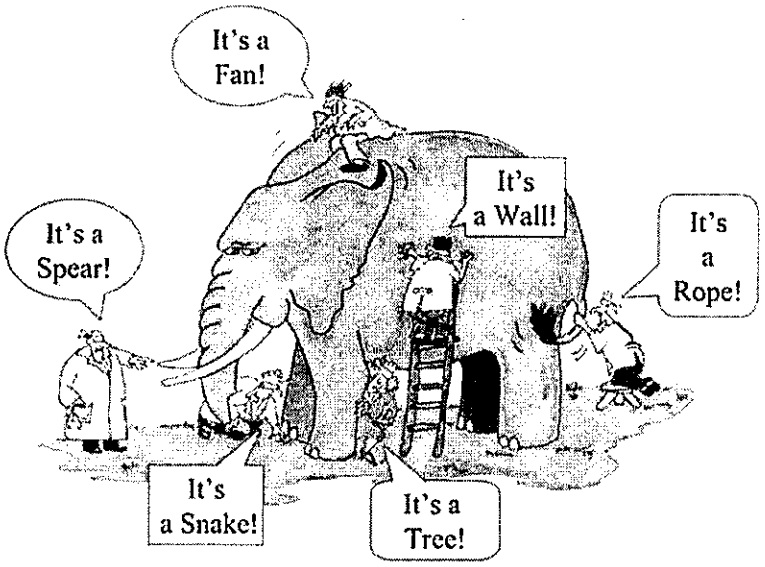
- Surroundings of the site
  - 2 miles near the site
  - Nearby factories or potential contamination sites

Site Assessment

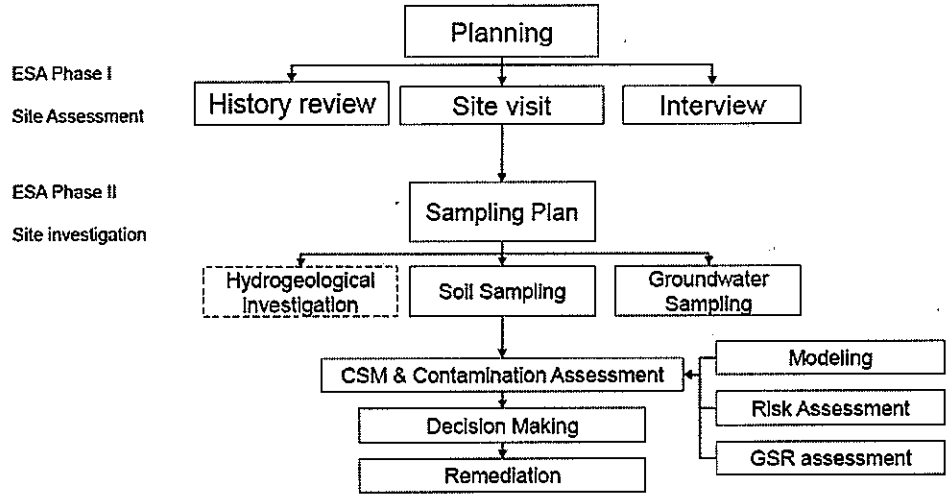
- Portable equipment
  - Bailer, Auger etc.
  - Heavy metals
    - XRF
    - Test kits for water
    - Screening tools for water
  - Organic compounds
    - Portable PID/FID
    - Portable GC or similar instruments
    - Test kits
    - GASTAC
  - Water quality
    - Water/oil meters
    - pH, ORP, DO meters
    - ...



Site Investigation



Site Investigation



Site Investigation

- When the results from Phase I indicate the potential contamination
  - Mainly rely on field investigation to obtain subsurface information
  - Heavy equipment and laboratory analysis are needed- time consuming and costly
  - To save money, often by several stages
    - Planning for next stage is based on the results from the previous stage.
- No standardized procedures
  - Site dependent
  - Different purpose have different sampling plans
  - Should also considering cost, number of samples, and items of monitoring depends on objectives

Site Investigation

- Geophysical Technologies
- Soil Gas sampling
- Soil Sampling and Analysis
- Groundwater Sampling and Analysis
- Hydrogeology investigation
- Screening/ In-situ Detection Technologies
- Data analysis

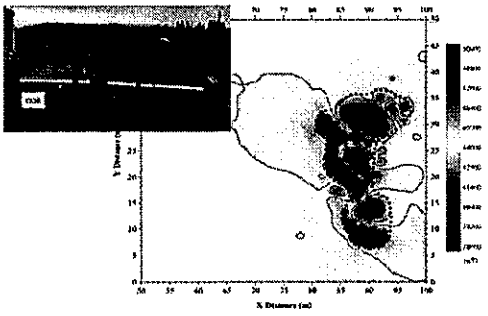
Geophysical Technologies

- Geophysical methods
  - Optional SI Methods
  - Indirect, Rapid and Relatively Cheap
  - Get hydrogeological and contamination information of large area instead of one point
  - Commonly used for
    - Mapping natural hydrogeological conditions
    - Detecting and mapping contaminant plumes
    - Locating and mapping buried objects

Geophysical Technologies

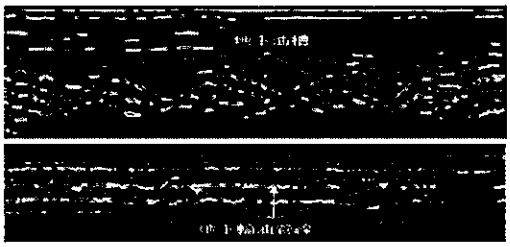
ElectroMagnetic, EM

- Mapping geologic deposits
- Locating subsurface cavities and trenches
- Mapping contaminant plumes (inorganic and sometimes organic), and sea water intrusions
- Locating buried tanks, drums, and subsurface utilities



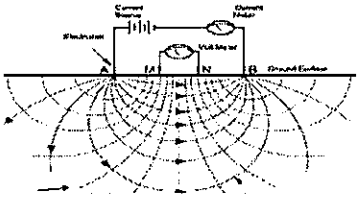
Ground Penetrating Radar, GPR

- Voids and underground trenches
- Buried drums of both metal and plastic.
- Floating hydrocarbon products



Geophysical Technologies

- Electrical Resistivity Tomography, ERT
  - The resistance to current flow as a result of an applied electrical potential
  - Dry soils, rock, and organic contamination
    - high resistivity
  - Inorganically contaminated saturated soils
    - relative low resistivity

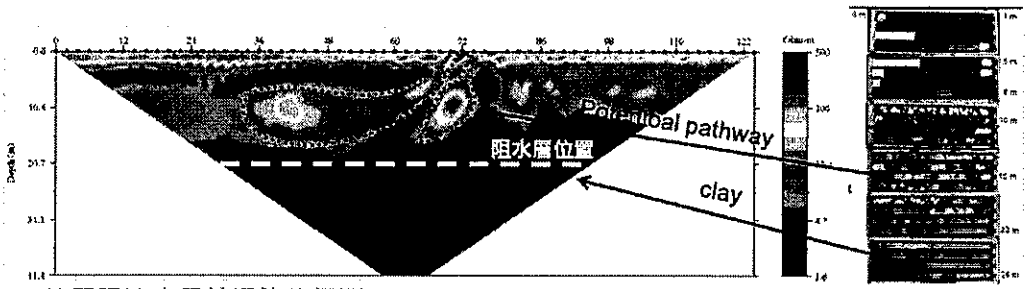


Measured ranges of resistivity for some typical materials

Igneous	100 – 1,000,000 ohm-m
Altered granite	1-100 ohm-m
Limestone	10 – 10,000 ohm-m
Sandstone	10 – 1,000 ohm-m
Dry Gravel	600 – 10,000 ohm-m
Alluvium and Sand	10 – 800 ohm-m
Clays	10 – 100 ohm-m
Soil	1 – 10 ohm-m
Fresh Water	3 – 100 ohm-m
Copper (native)	0.0000002 ohm-m

Geophysical Technologies

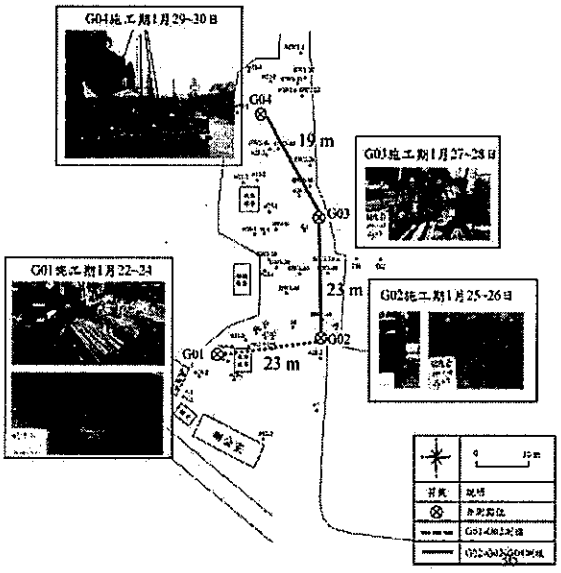
- Electrical resistivity tomography, ERT

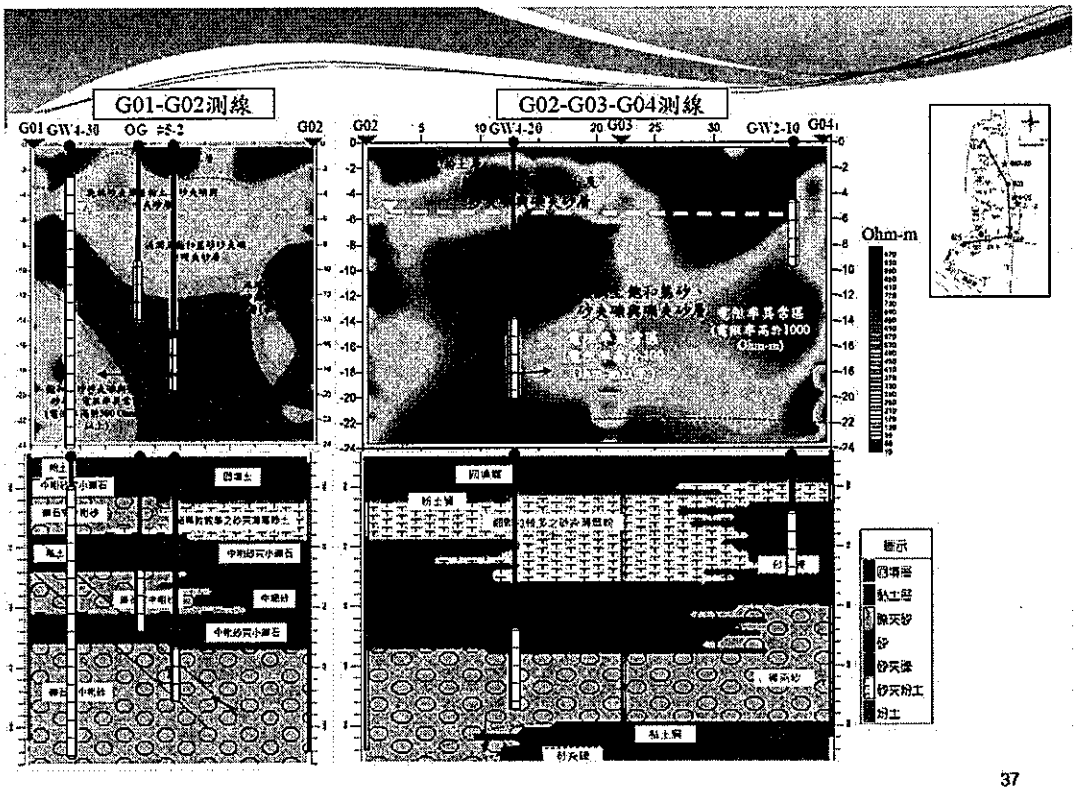


地電阻法應用於污染物探測

Geophysical Technologies

- ERT
  - Vertical and horizontal electrodes arrangement
  - Inter Well ERT
    - Bipole – Bipole Array was selected as the analytical method of inter well ERT
    - Higher Resolution
    - Can understand the geological construction and pollution distribution
    - Electrodes can be preserved for long-term monitoring





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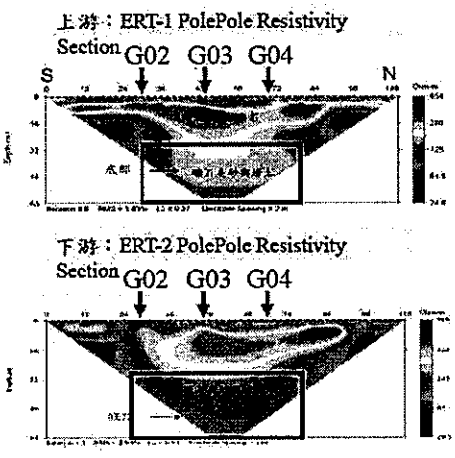
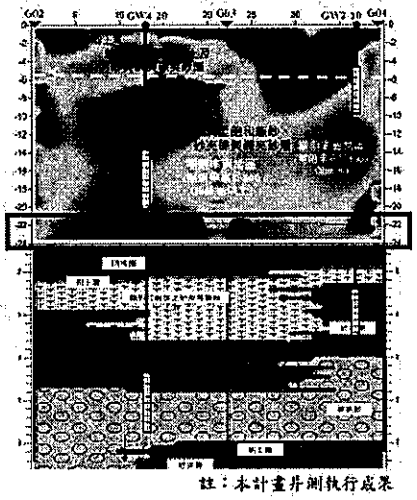
Geophysical Technologies

- Compared with horizontal ERT results. We can figure out the layer of rock, sand with silt is similar with the Inter Well ERT.



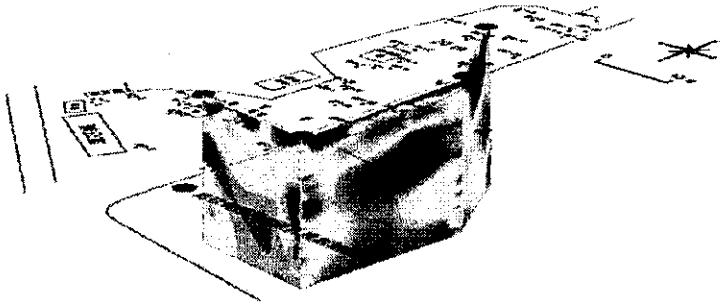
註：98~100年計畫地電阻成果



註：本計畫井測執行成果

Geophysical Technologies

- 3-7m BGS is a layer of rocks and silt
- An clay lens locate at 7m-15m of the SW part of this site. And there is a thin layer of clay at 22-24m BGS. We believed that the bottom free aquifer locates at 40m

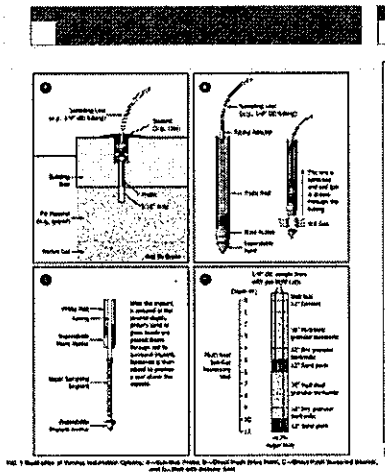


Soil Gas sampling and survey

- Optional method of SI
- Soil gas concentration can be indicators of…
  - Shallow subsurface biological process (CO_2, CH_4)
  - Organic compound contamination distribution
  - Vapor intrusion
  - Possible public concerns over geological storage of CO_2
- Soil gas sampling can help to map the potential contamination area of VOCs, including BTEX, chlorinated solvents

Methods to collect soil gas

Active Sampling Surface Flux Chamber Passive Sampler



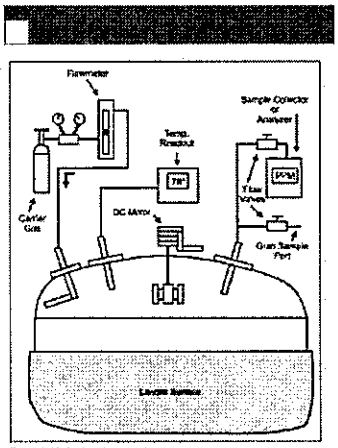


Figure 9.16 Surface flux chamber

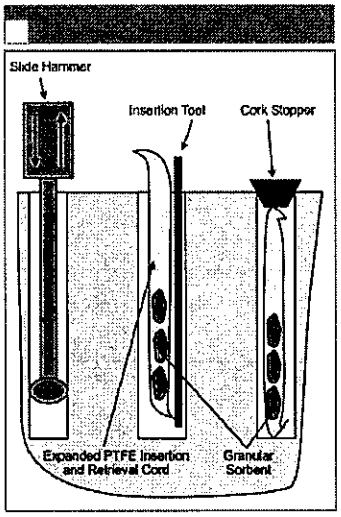
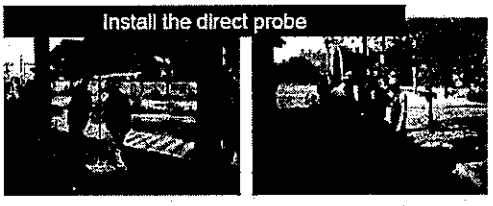
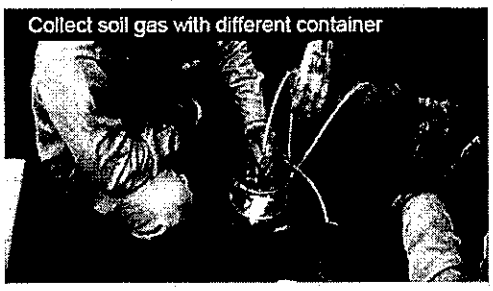


Figure 9.15 Passive sorbent sampler

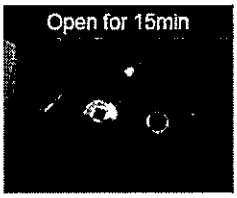
Soil Gas sampling and survey

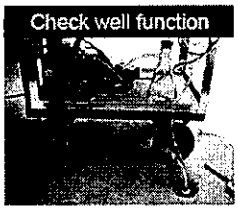
- **Active soil gas sampling**

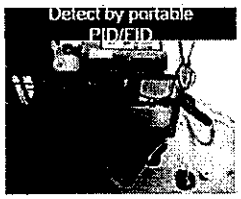




- **Soil gas monitoring wells of gas station**

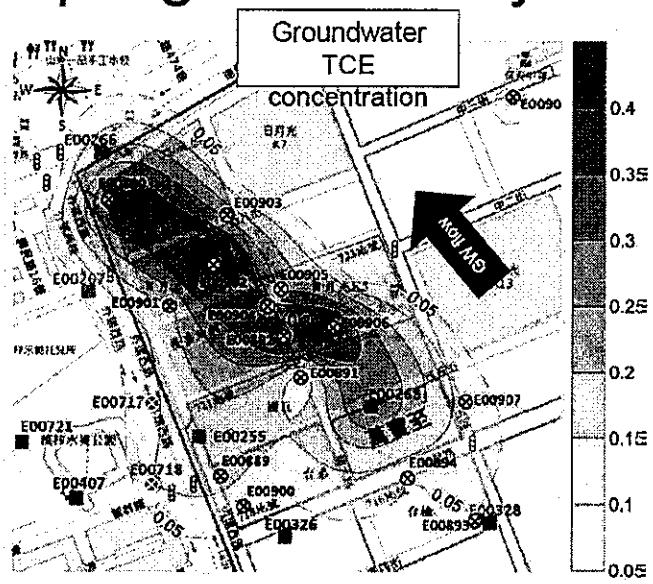


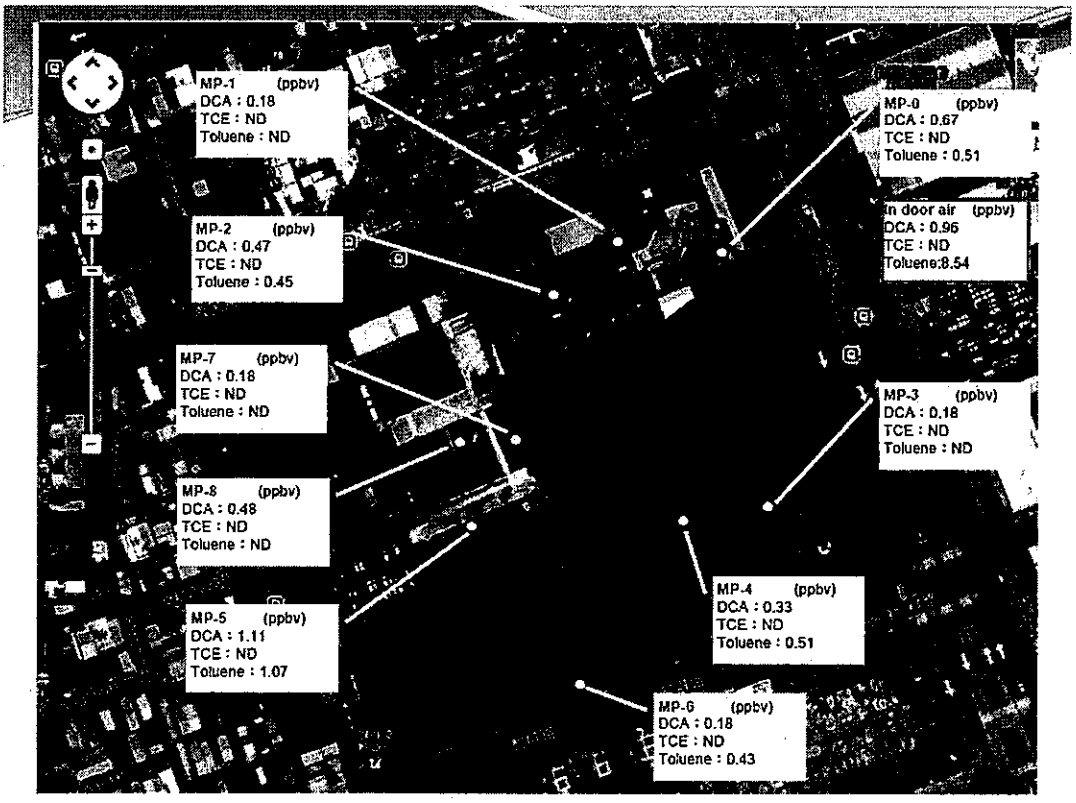




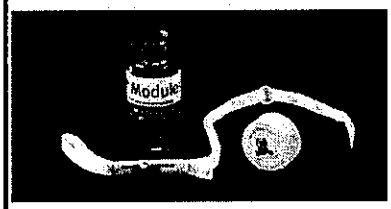
Soil Gas sampling and survey

- Surface Flux chamber



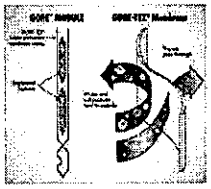


Commercial Products : Module

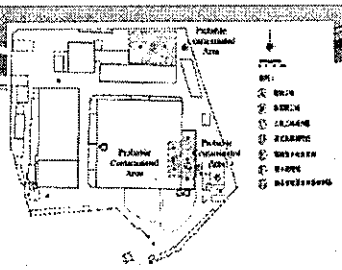


- Actual size: 18 mm x 60 mm
- Two types of adsorbents
- Two pairs of adsorbents for duplicates
- verified with analytical balance
- Adsorbents are hydrophobic
- Completely inert sampler

- Chemically-, biologically- inert, microporous, waterproof, and vapor permeable membrane (GORE-TEX® membrane)
- Containing engineered, hydrophobic adsorbents



Soil sampling

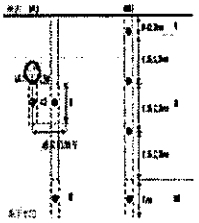


- Sampling Plan
  - Judgmental sampling
  - Simple random sampling
  - Stratified sampling
  - Systematic and grid sampling
  - Adaptive cluster sampling
  - Composite sampling
- Sampling depth
  - Site dependent
  - Contaminants dependent
    - Farmland
    - Gas station
    - Factories
    - Dumping sites

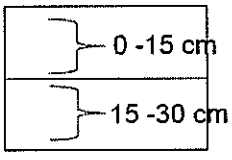
potential contamination area

1. Unknow contamination area
2. Detail site investigation

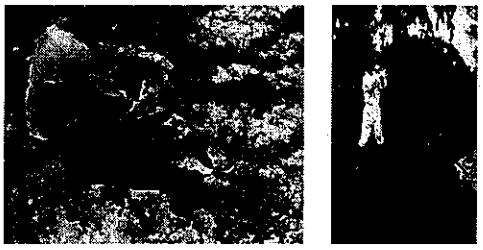
Underground piping/tank

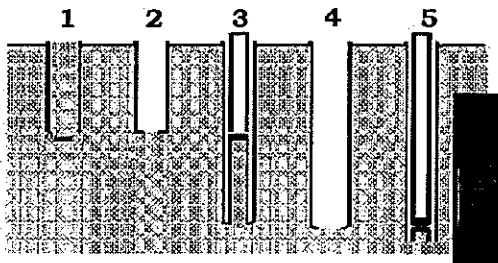


Farmland



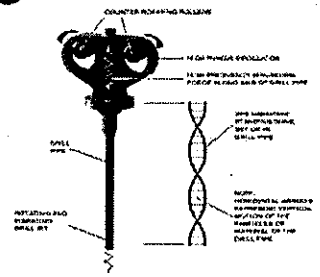
Soil sampling





Soil sampling

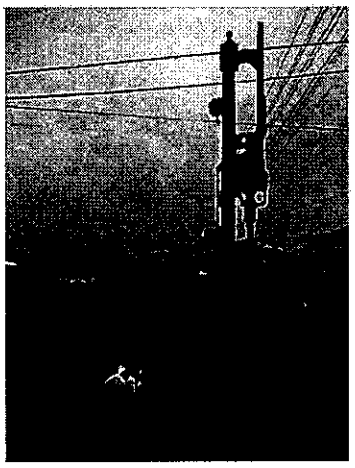
- Sonic Drilling
  - Fast
  - Can continuously collect sample
  - Add water for unsaturated zone sampling, may cause unwilling lost of the contamination
  - Not good for VOCs polluted soil sampling

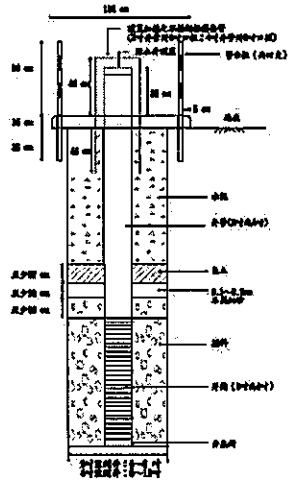


Continuously sampling

Groundwater sampling

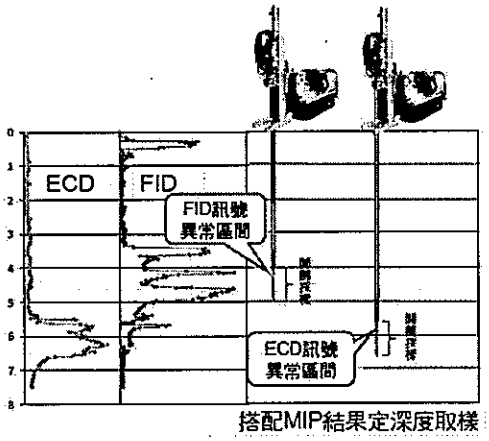
- Install wells for monitoring or contamination investigation



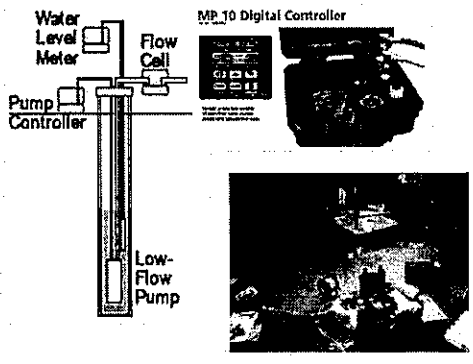



Groundwater sampling

- Direct sampling
- Micropurge



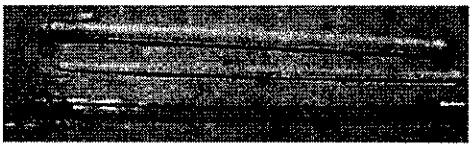
搭配MIP結果定深度取樣



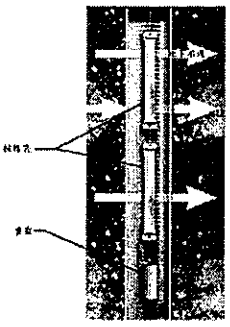
Groundwater sampling

- Bailer
- Passive sampling bag

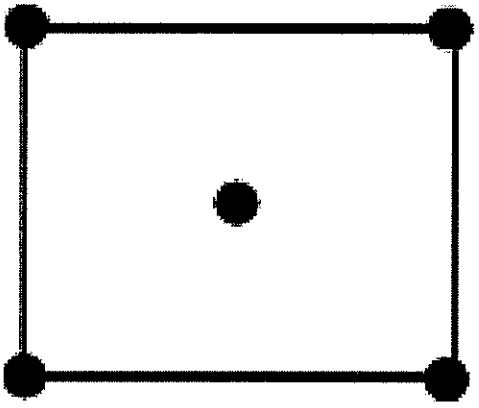
Teflon Bailer for VOCs

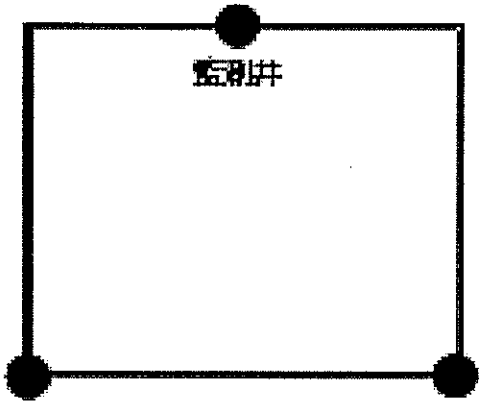


Bailer for general sampling



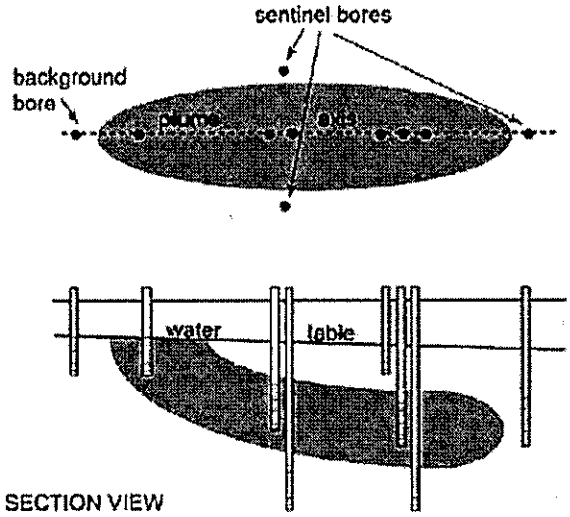
Groundwater sampling





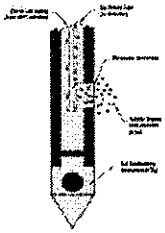
The optimum GW monitoring wells distribution planning	The alternative GW monitoring wells distribution planning

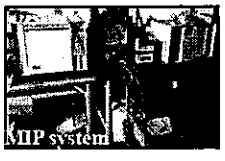
Groundwater sampling



In-situ Detection Technologies

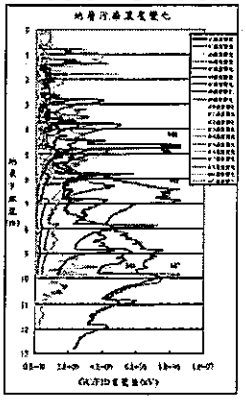
- Membrane interface probe
  - Save Sampling Time, and Cost
  - Collect Geo-data in the same time at each Point Quickly
  - Screening Soil Sampling Point/ MW Location





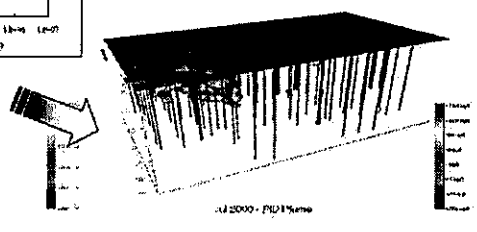
偵測器	適用污染物	偵測範圍 (ppm)	使用氣體
PID	HCs and some cVOCs	0.20-2.0	Carrier1
FID	HCs especially benzene	10-20x PID/XSD	Carrier,H2, Air
ECD	cVOCs (PCE, TCE)	0.20-2.0	Carrier
DELCD	HCs, and cVOCs (PCE, TCE, DCE)	0.20-2.0	Carrier, Air
XSD	HC, and cVOCs(PCE, TCE, DCE, VC)	0.10-2.0	Carrier, Air

In-situ Detection Technologies

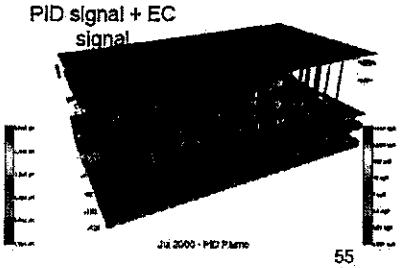


- MIP
  - Only suitable for the sand, silt and clay
  - Limited by the direct push depths.

3D distribution



PID signal + EC signal



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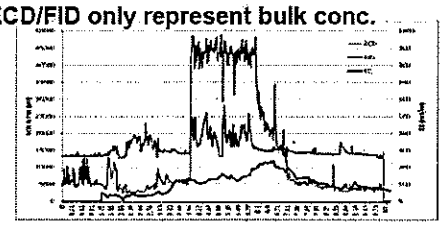
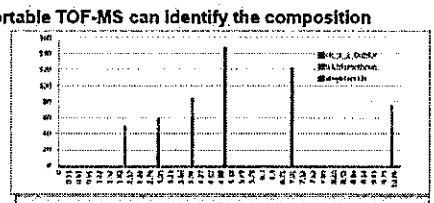
In-situ Detection Technologies

- MIP combined with portable TOF-MS

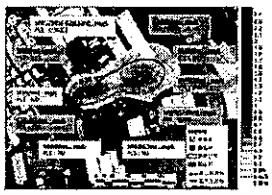
ECD/FID only represent bulk conc.



Portable TOF-MS can identify the composition

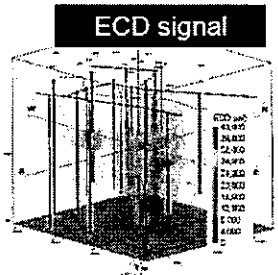


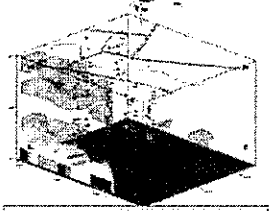
MIP -TOF-MS



PCE

ECD signal





1,2-DCA

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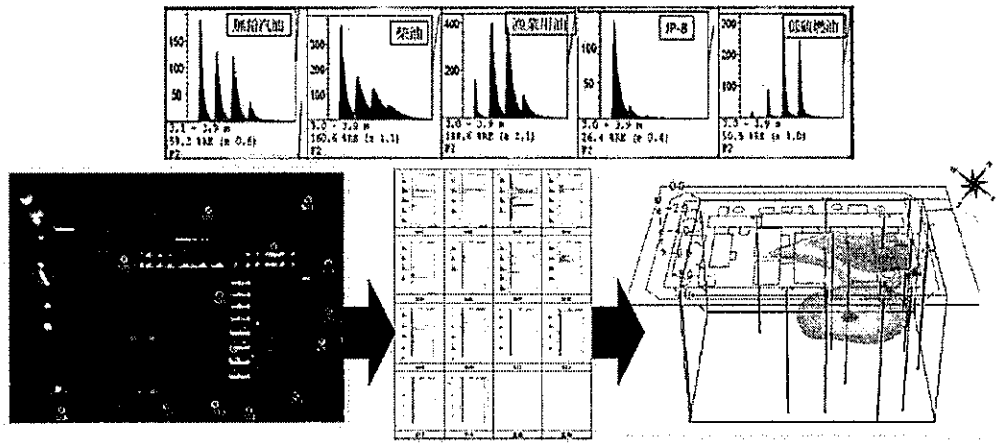
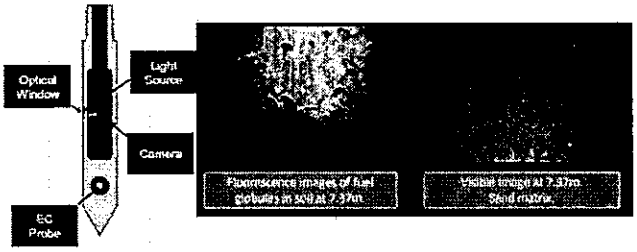
In-situ Detection Technologies

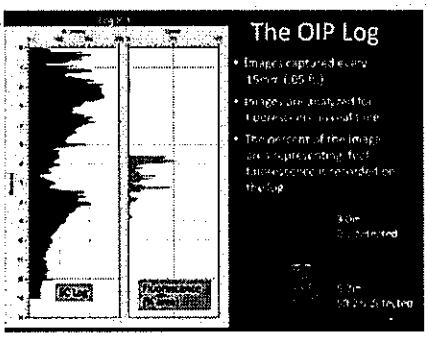
- Laser Induced Fluorescence, LIF

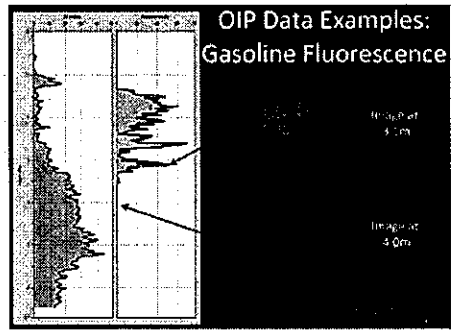


In-situ Detection Technologies

- Geoprobe Direct image®
  - Similar to LIF
  - Use CCD to collection image data and flourescence signals

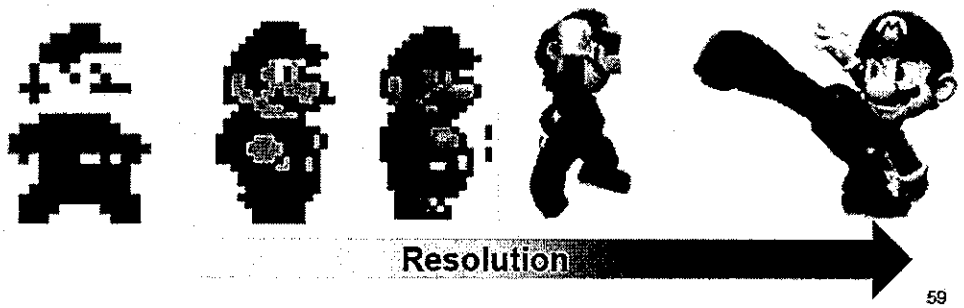




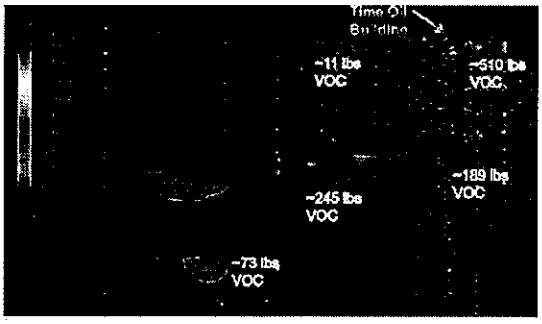


High Resolution Site Characterization

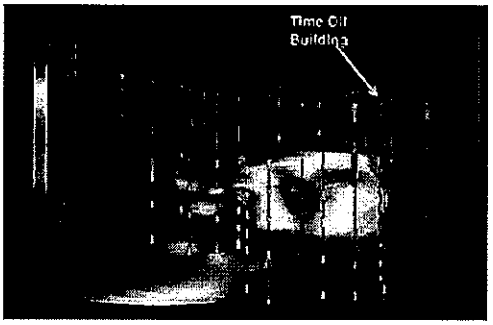
- Have a precise CSM
- Shorter sample distance, higher sample point density
- More is better, but more is expensive
  - Rely on real-time analysis



High Resolution Site Characterization



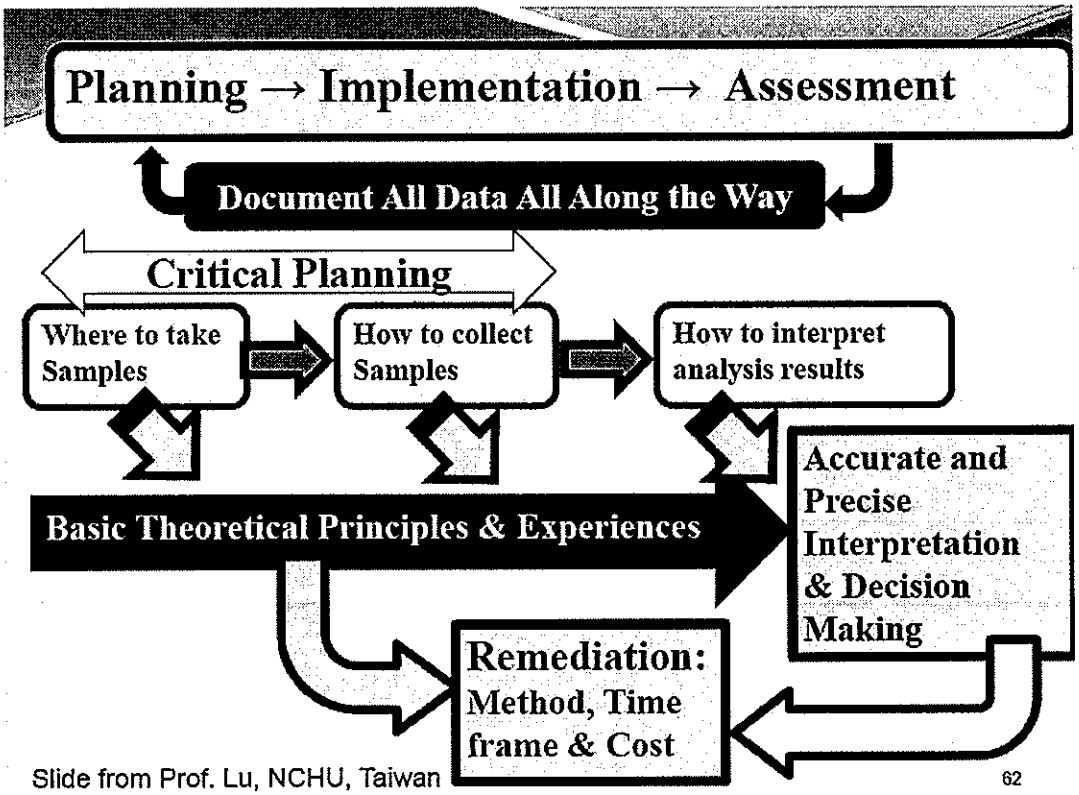
DNAPL Pool



Plume distribution

Conclusions

- Successful site assessment and site investigation
  - Define investigation purpose
  - Know where and how to collect site information
  - Use Screening Tools (Methods) and real-time analysis tools
- Development of CSM is important for decision making and remedies design
  - High resolution site characterization



Slide from Prof. Lu, NCHU, Taiwan

- Thank you for your attention!
- Question?

2019 Taiwan – Philippines
Workshop on Soil and Groundwater Contamination Site Investigation and Remediation

Contamination Forensics and Post-treatment Planning of an illegal dumping site in Taiwan

Meng-Der Fang, Pey-Horng Liu, Ta-Ko Chen, Claudia Chen

Green Energy & Environment Research Laboratories,
Industrial Technology Research Institute
2019.03.08

Contents

- Introduction
- Methodology of the Site Investigation
- Strategy of the Site Remediation
- Combination with the Urban Planning of Kaohsiung City
- Conclusion

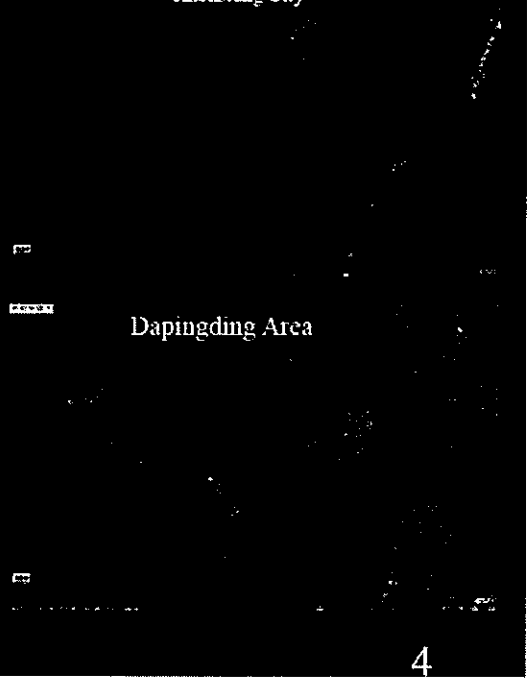
工業技術研究院
Industrial Technology Research Institute

Introduction

3

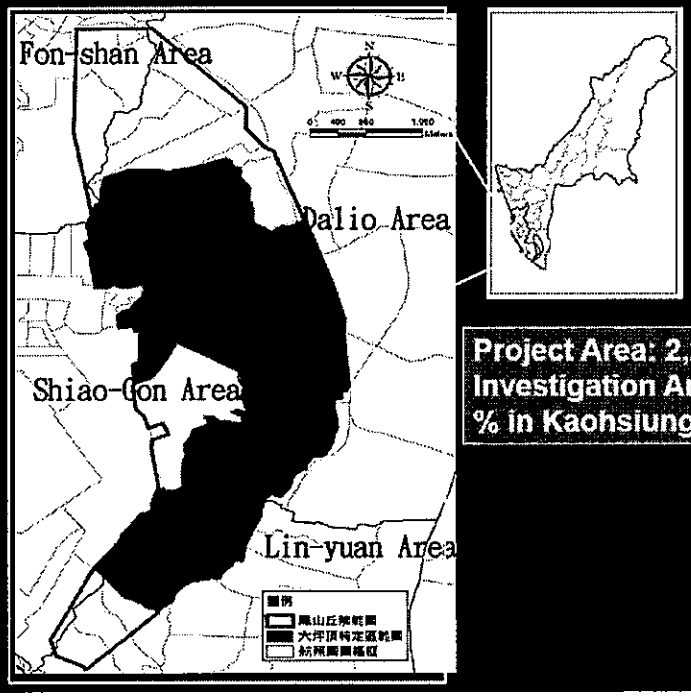
Location of the Dapingding Area

- Located in the south of Kaohsiung City, non-urban area, low in population density
- Surrounded by the Kaohsiung LinHai Industrial Park (steel manufactures), the Linyuan Petrochemical Industrial Park (petrochemicals manufactures), and the DaLiao Industrial Park (chemicals manufactures)
- Neighboring a Residential Area within the Kaoping Urban Plan



4

Dapingding Area



Project Area: 2,214 Hectare
Investigation Area : 3,281 Hectare
% in Kaohsiung : 1.1%

History

Hilly landscape and part of the area was quite remote

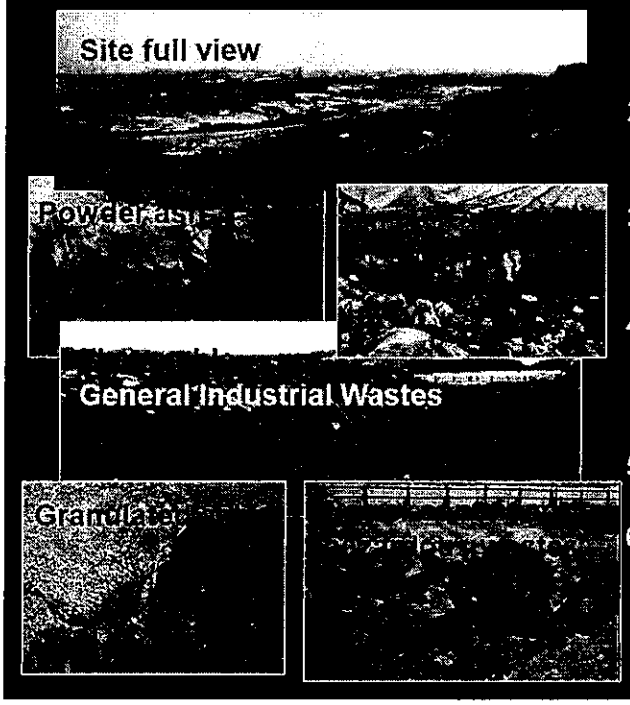
Due to fast industry growth between 1980 and 2000, untreated industrial wastes were illegally disposed including hazardous wastes.

8 illegal dumping sites were found in 2000. The estimated total area were about 10 hectares. 2 out of the 8 sites contained highly hazardous solid and barreled liquid wastes. Soil and groundwater were contaminated with heavy metals and organics like phenol and benzene.

Contamination investigation and clean-ups of the 2 highly hazardous sites were conducted in 2002 and finished in 2008.

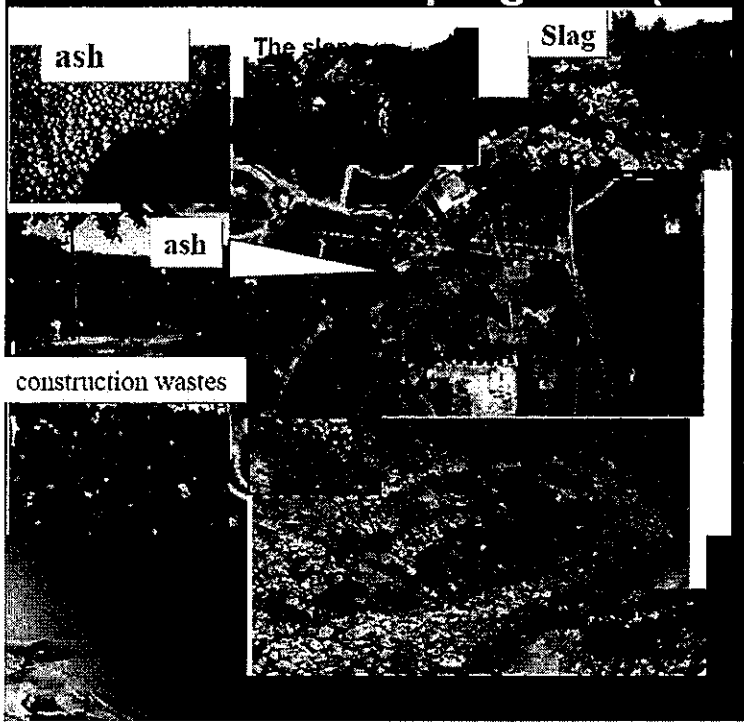
Another site containing wastes from steel industry was found in 2005, and its clean-up started in 2008.

Hung-shia-shan Site (2000-2008)



1. Clean-ups between 2004 and 2008
2. 4,342 barrels of wastes; 2,572 tons of ash from steel industry
3. 14, 543 tons of combustible wastes and 1,242 tons of non-combustible wastes
4. About 100,000 metric meters of slag, construction materials, and sandblasting residues were left on site.
5. Phenol concentrations were below the TWEPA limits.
6. Cost of the clean-up was about US$ 5 million.

Tam-ping Site (2006-2011)



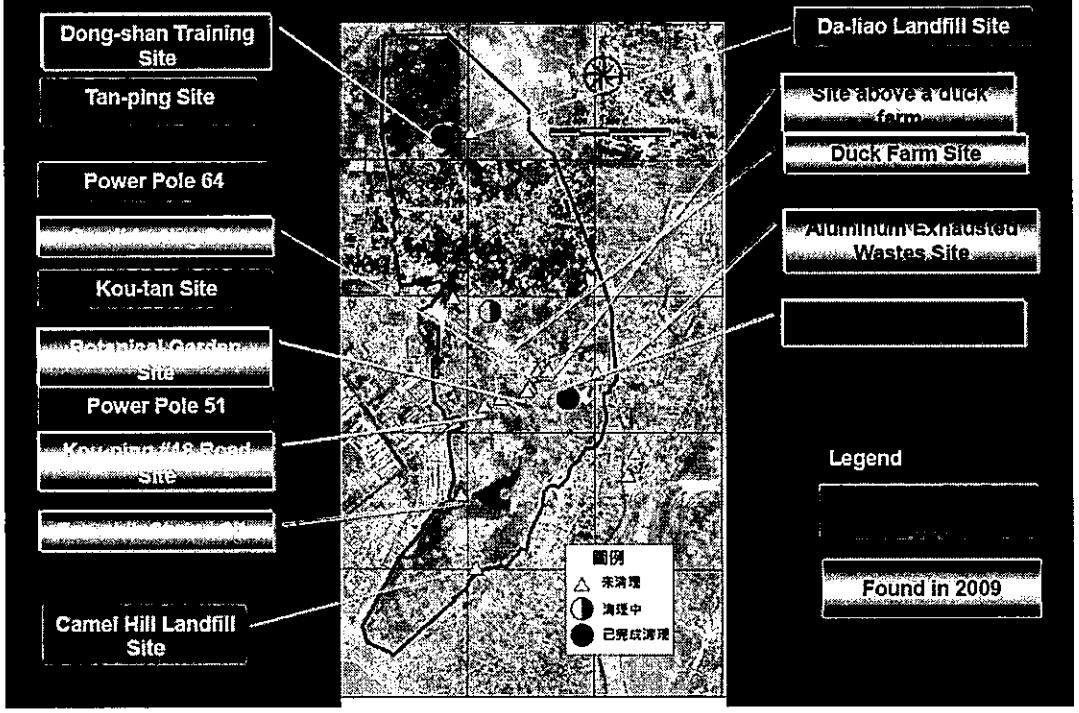
1. 2 hectares in area; 16 meters deep
2. 204,000 cubic meters of wastes
3. Estimated 70,295 tons of hazardous ash from steel industry
4. 157,000 cubic meters of slag, construction wastes and general wastes

Cost Statistics

Site	Area (Ha)	Waste Volume (m^3)	Hazardous Wastes (ton)	Cleanup Cost (1k NTD)	Cost per unit area (1k NTD/Ha)
Hung-shia-shan Site	3.523	113,350	3,308	**145,470** (Hazardous only)	41,291
Dong-shan training site	0.330	11,067	10,215	**120,000**	363,634
Tan-ping Site	2.000	204,000	70,295	**1,017,507** (Hazardous only)	508,7,54
Total	5.853	328,417	83,818	**1,282,977**	

Total: 41.3 million US

Known Contamination Sites



Farm Contamination

7 sites were found in 2009. The estimated total area was about 11 hectares. One out of the 7 sites was a duck farm. The ducks were contaminated with dioxins and the source of the contamination was assessed the wastes underneath. All the ducks were removed and culled.

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Problem of Full-scale Investigation & Cleanup

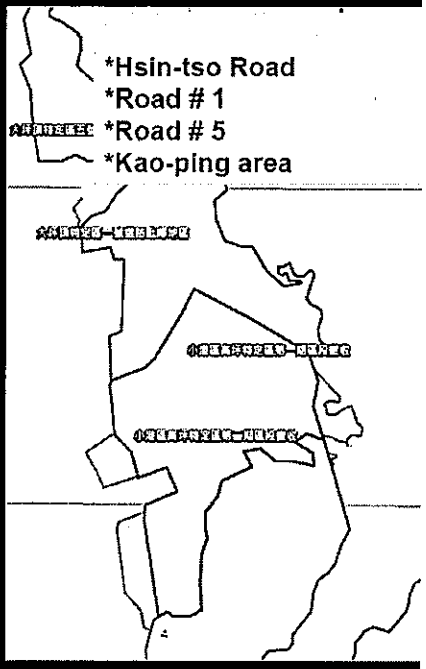
Land Management after cleanup
- Low land use: illegal disposal continues

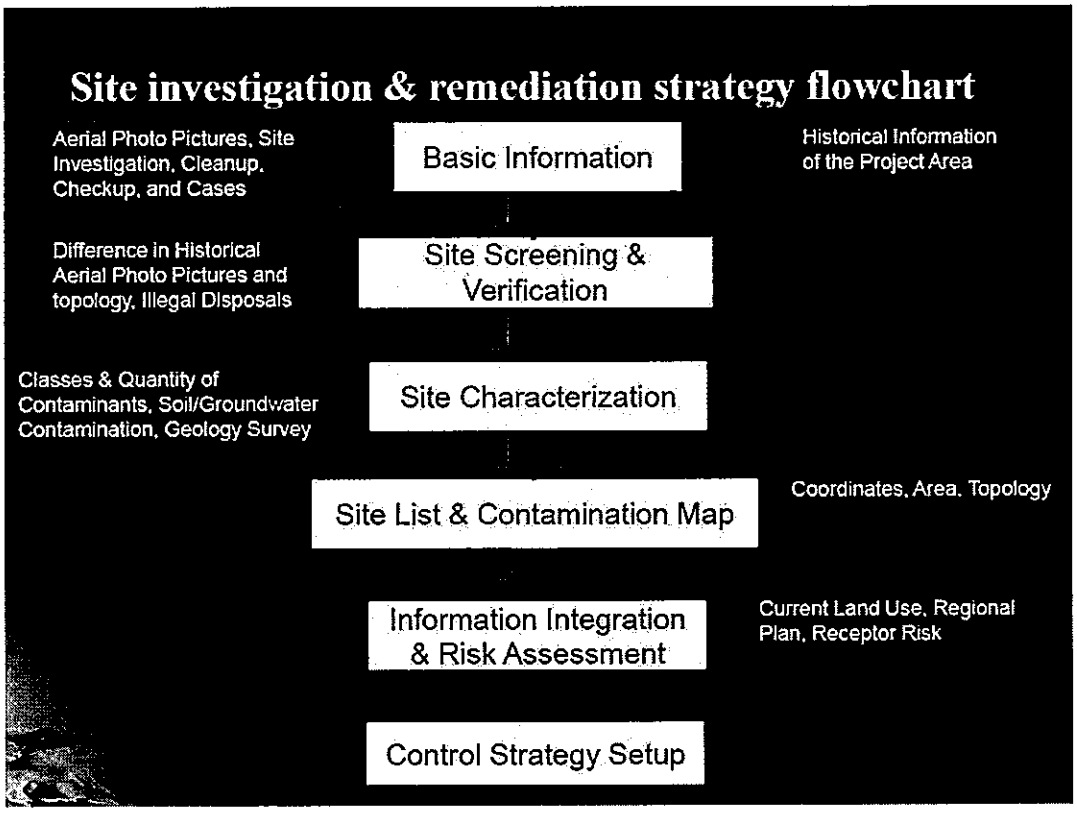
Urban Planning
- Road availability: easier to access for disposal
- Contamination affects urban development

Remediation Cost & Treatment Capacity
- Over 150 Hectare of land is suspicious
- Over 3 million tons of hazardous wastes
- Over 8 million m^3 of contaminated slag and construction wastes
- Over 800 k m^3 of contaminated soil

Domestic capacity is limited.

Total cost over 1.7 billion US$




Site investigation & remediation strategy flowchart
Aerial Photo Pictures, Site Investigation, Cleanup, Checkup, and Cases
Basic Information
Historical Information of the Project Area
Difference in Historical Aerial Photo Pictures and topology, Illegal Disposals
Site Screening & Verification
Classes & Quantity of Contaminants, Soil/Groundwater Contamination, Geology Survey
Site Characterization
Site List & Contamination Map
Coordinates, Area, Topology
Information Integration & Risk Assessment
Current Land Use, Regional Plan, Receptor Risk
Control Strategy Setup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Methodology of the Site Investigation
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Objectives

- Site boundaries and contamination range
- Current land use and land owner information
- Time of disposal and history of disposal rebuilt
- Classification and quantification of the wastes, soil and groundwater contamination
- Hydrology and geology information
- Strategies of clean-ups and remediation
- Estimates of remediation cost and time frame
- Information gathering of the responsible parties

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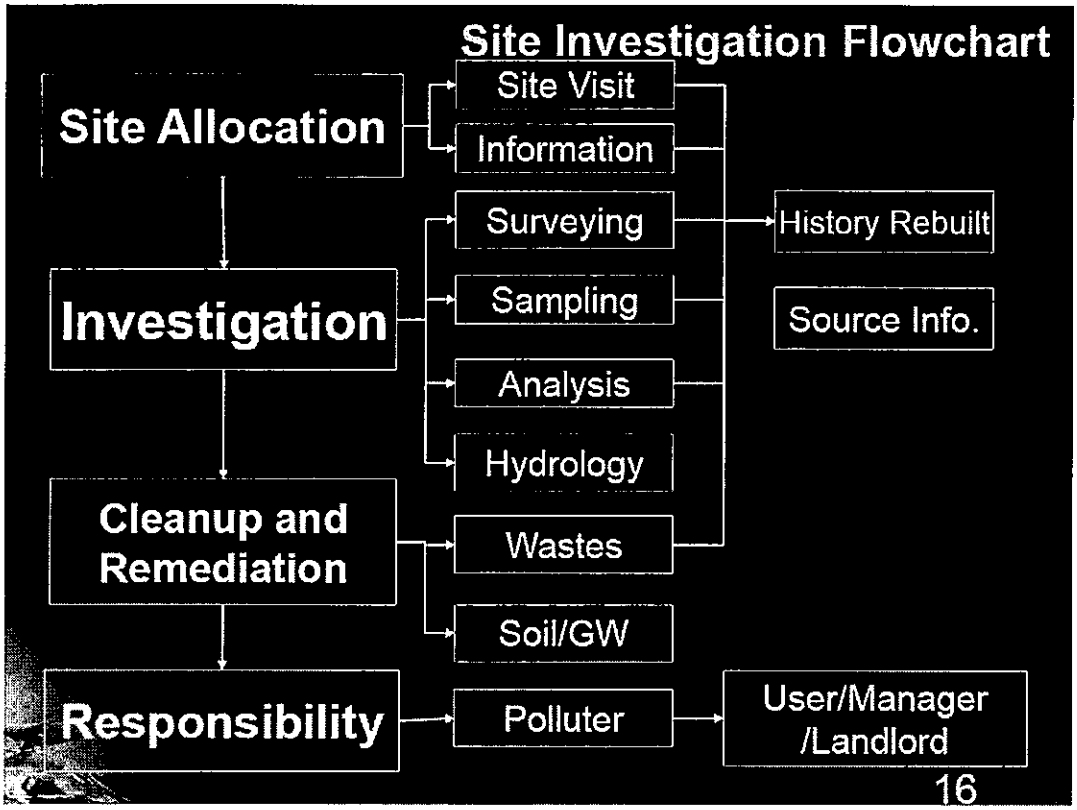

Site Allocation and Verification

Aerial Photography Application

Change in Landscape

- Change in color of the aerial photo can be used to identify the change in vegetation, ponds, woods or farm lands, road extension or shortening, or building disappearance

Change in Elevation

- The flat lands are on the [illegible] slope slopes in 1976, and the elevation of the reclaimed area increased by [illegible] in 1996

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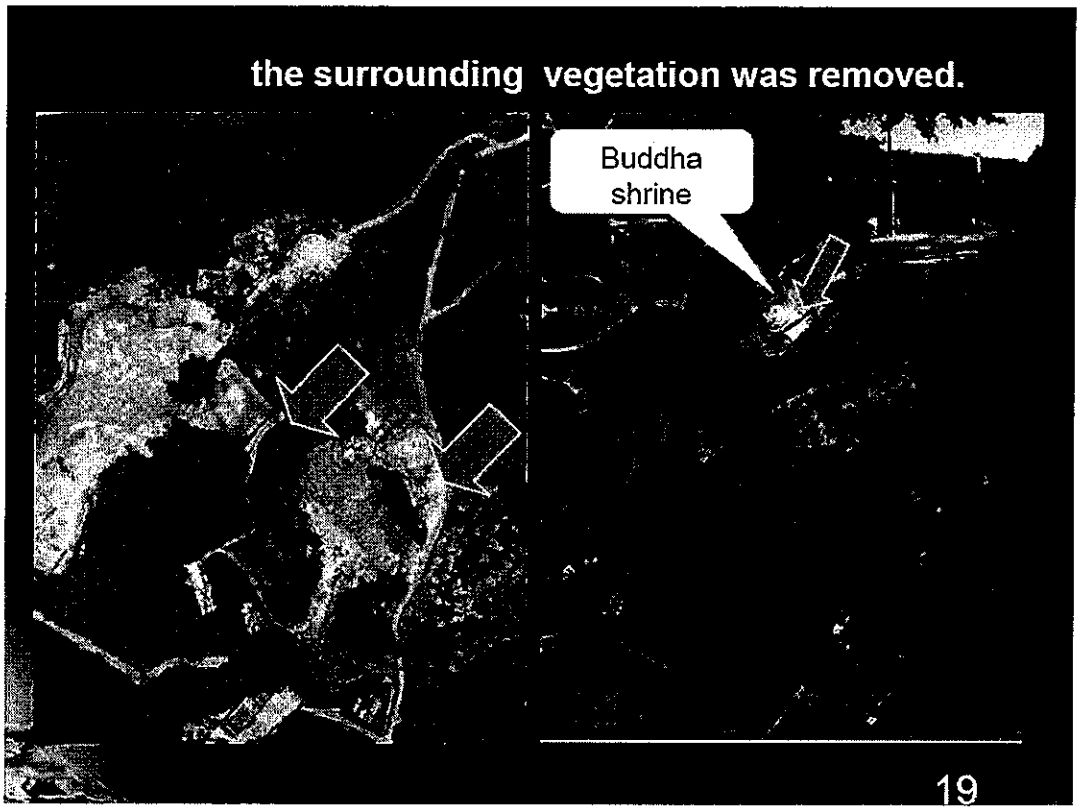
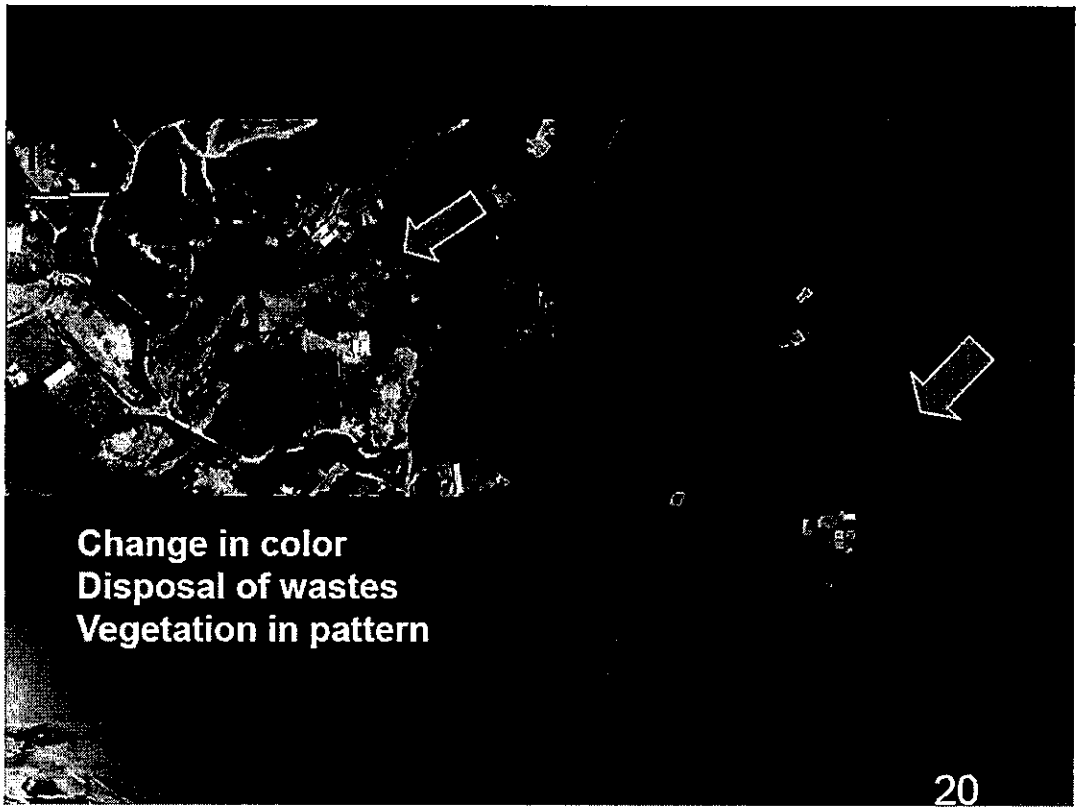
Example: Change in Landscape

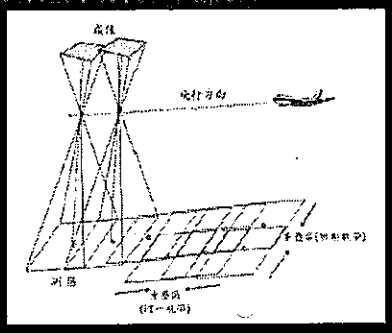
18

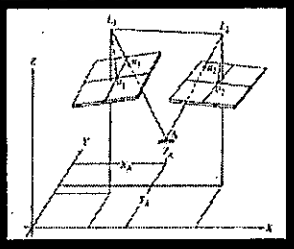

the surrounding vegetation was removed.
Buddha shrine
19


Change in color
Disposal of wastes
Vegetation in pattern
20

Construction of Digital Elevation Model

* Aerial Photography



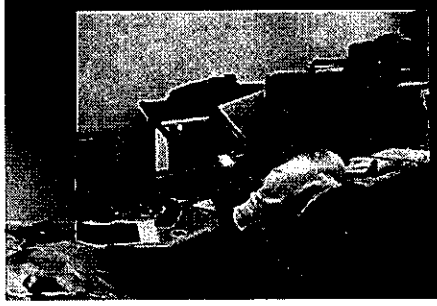


Imaging Analysis

$$X_a = -f\frac{(X_A - X_C)r_{11} + (Y_A - Y_C)r_{12} + (Z_A - Z_C)r_{13}}{(X_A - X_C)r_{31} + (Y_A - Y_C)r_{32} + (Z_A - Z_C)r_{33}}$$

$$Y_a = -f\frac{(X_A - X_C)r_{21} + (Y_A - Y_C)r_{22} + (Z_A - Z_C)r_{23}}{(X_A - X_C)r_{31} + (Y_A - Y_C)r_{32} + (Z_A - Z_C)r_{33}}$$

$$R = \begin{bmatrix} \cos\phi\cos\kappa & -\cos\phi\sin\kappa & \sin\phi \\ \cos\omega\sin\kappa + \sin\omega\sin\phi\cos\kappa & \cos\omega\cos\kappa - \sin\omega\sin\phi\sin\kappa & -\sin\omega\cos\phi \\ \sin\omega\sin\kappa - \cos\omega\sin\phi\cos\kappa & \sin\omega\cos\kappa + \cos\omega\sin\phi\sin\kappa & \cos\omega\cos\phi \end{bmatrix}$$



Simulating human eyes for object observation with overlapping focuses and baselines. This can be used on the same 2-D point to form a 3-D image. Through 3-D observation, the objects on the land surface can be analyzed for their heights.

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Establishment of Surveying and Control Points

* **GPS Surveying**

Base Surveying

Check Point Identification

Control Point Surveying

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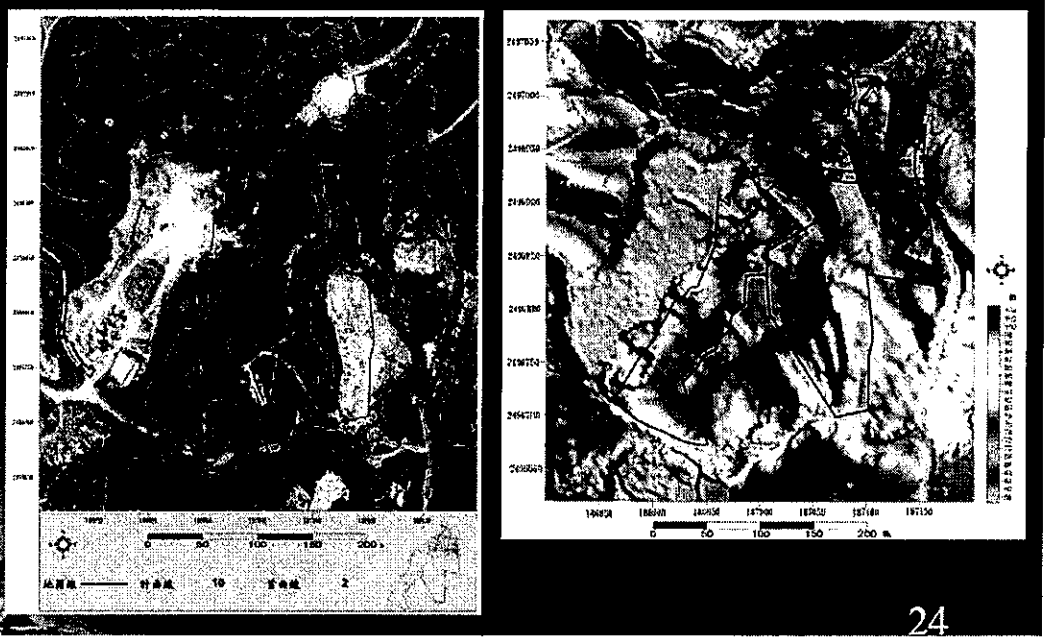
Results of the Digital Elevation Model

* 1993



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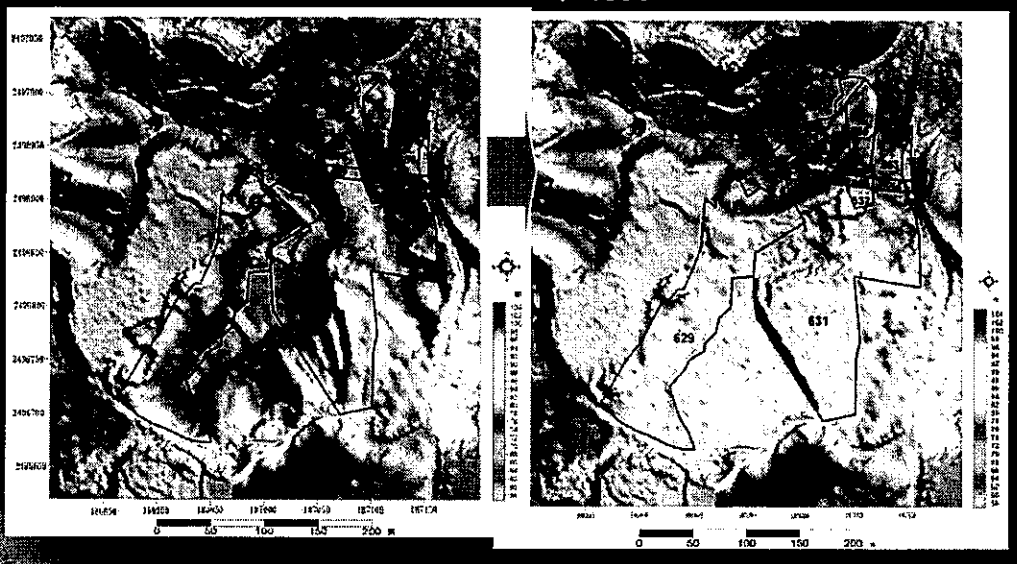
Comparison

* 1993

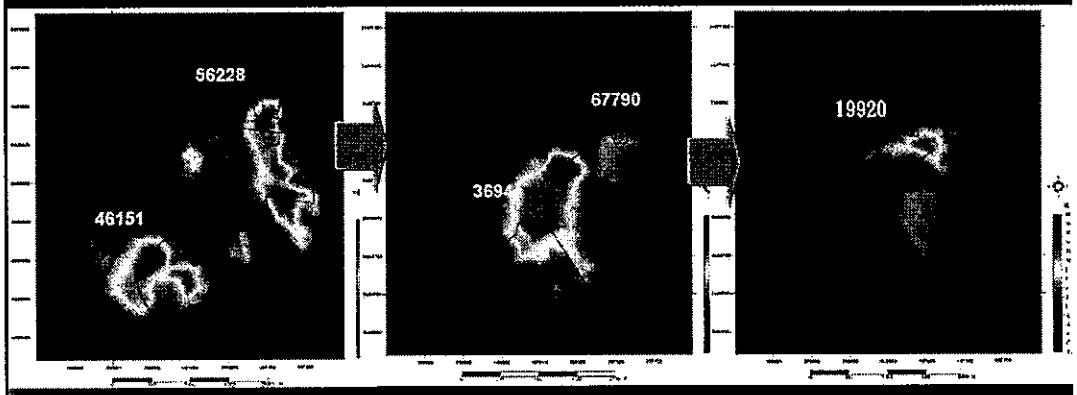
* 1996



25

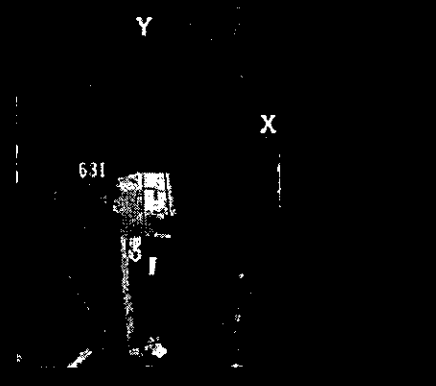
Change in Elevation

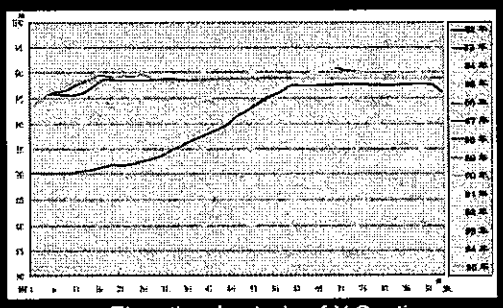
* Change in 1993-1994 * Change in 1994-1995 * Change in 1995-1996



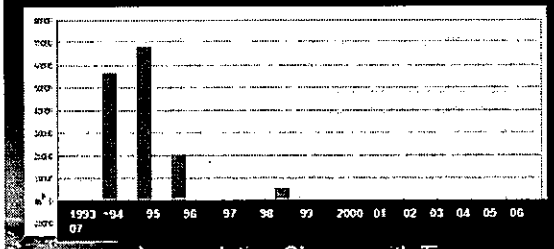
26

Change in Accumulation

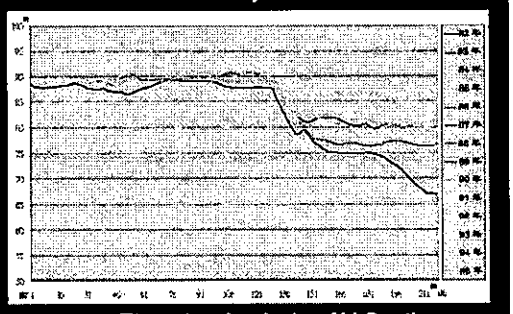




Elevation Analysis of X Section



Accumulation Change with Time

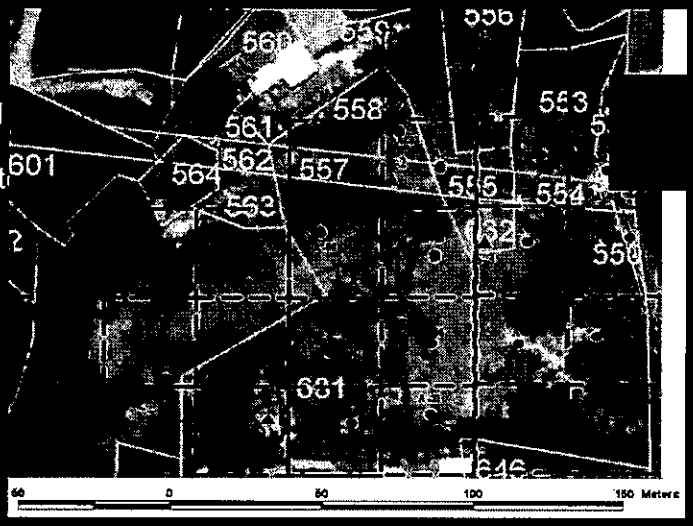


Elevation Analysis of Y Section

27

Site Investigation on Wastes Distribution & Characteristics

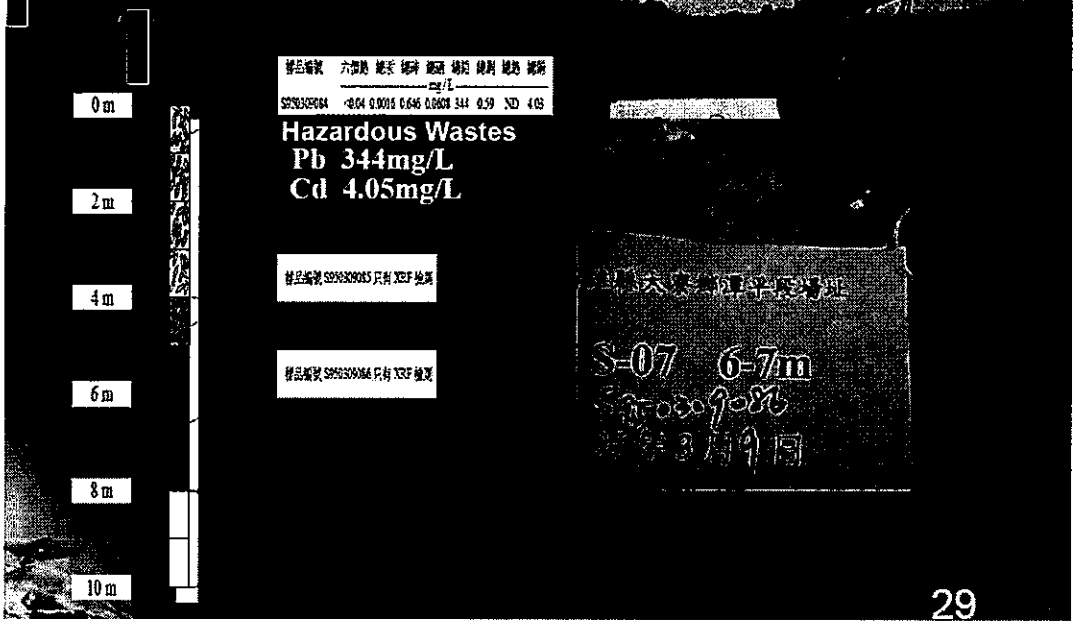
- Systematic Sampling
- Gather Vertical and Horizontal Information of Wast Distribution
- Hazard Characteristics



Note : Blue dots represent digging locations/
Red triangles represent soil surveying locations

28

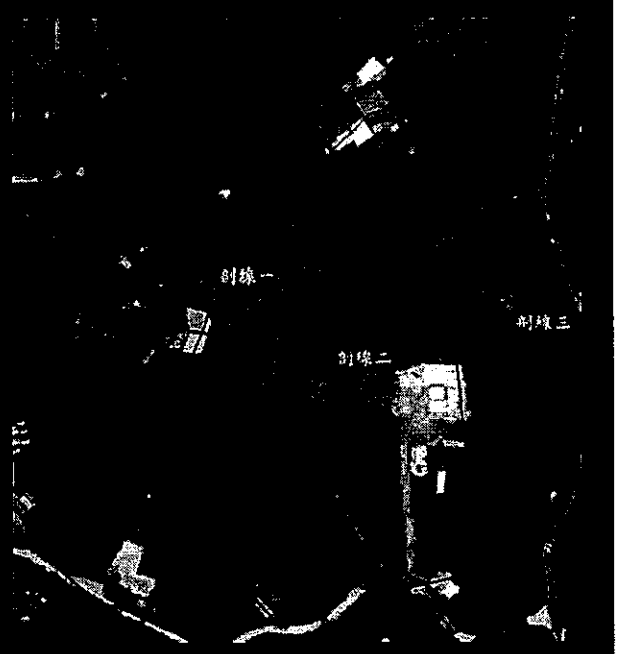
Vertical Info. With Soil Surveying



29

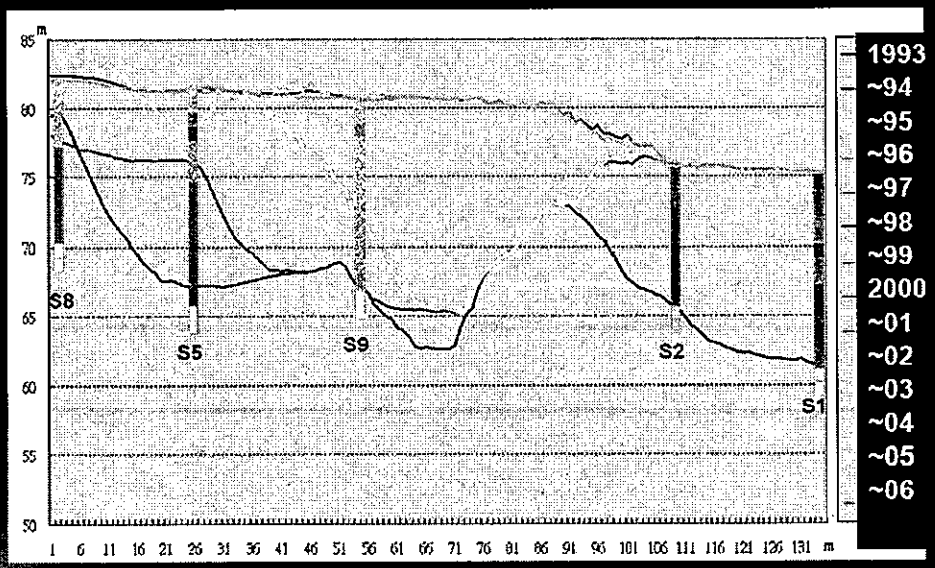
Disposal History Retrieval Assessment

- Digital Elevation Model & On-site Visit Information
  - Estimates of disposal time
  - Kinds of wastes
  - Responsibility between land-related parties or owners
  - Basis of cleanup cost sharing



30

The surveying results show the time of disposal



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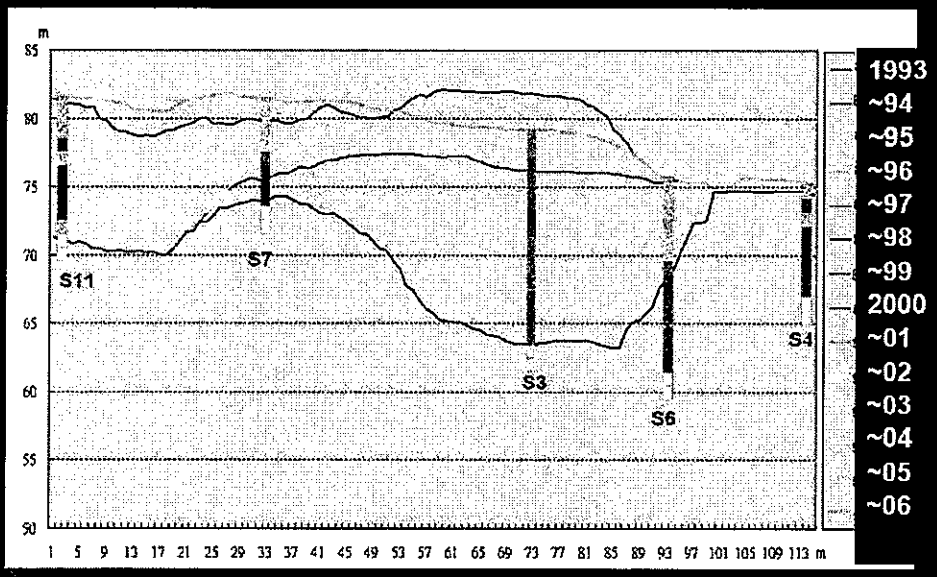
Disposal History Rebuild & Assessment



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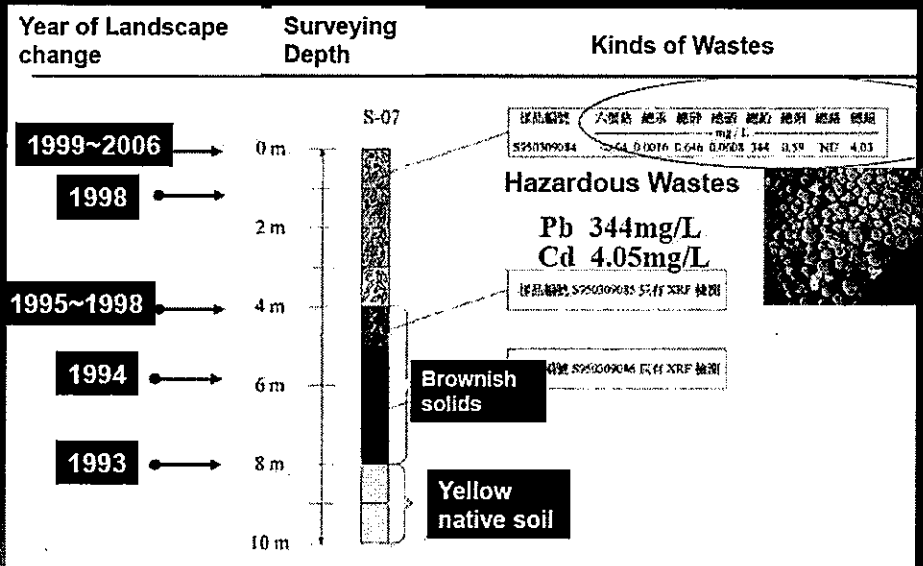
Disposal History Rebuild & Assessment

Combined with the changes in elevation and surveying information to assess the disposal time, including wastes depth.



33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Strategy of the
Site
Remediation
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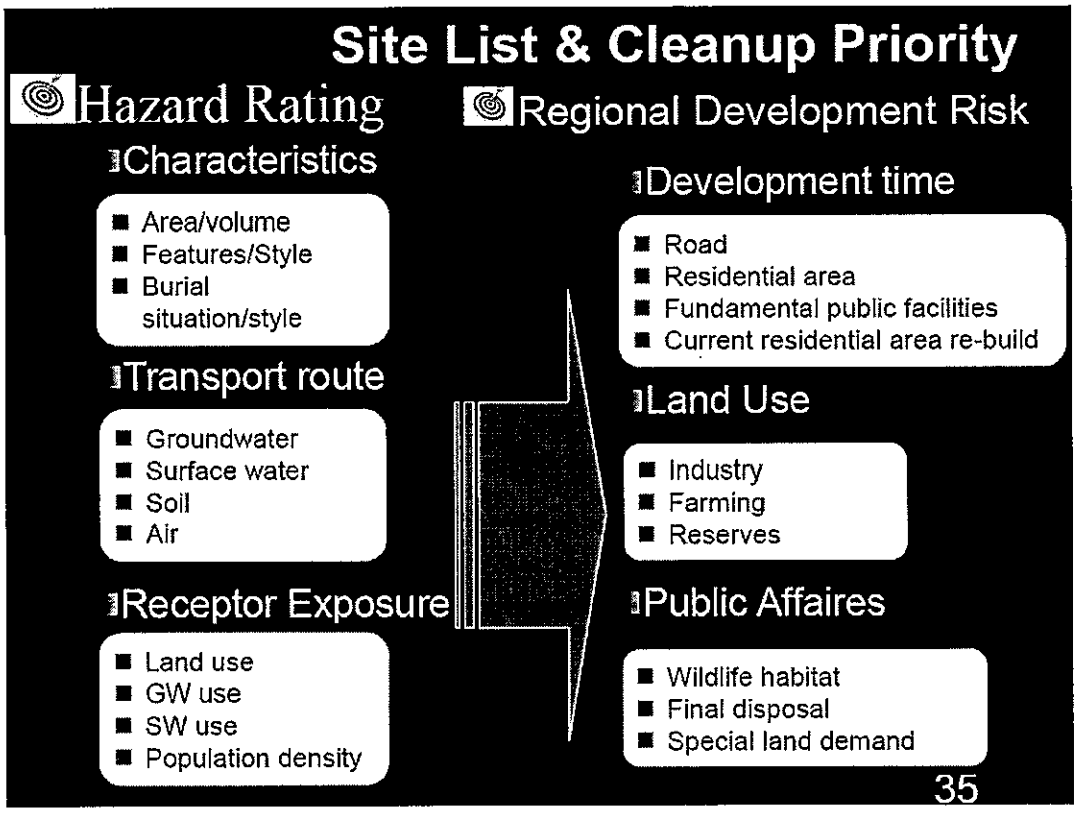
Site List & Cleanup Priority
Hazard Rating
Characteristics
Area/volume
Features/Style
Burial situation/style
Transport route
Groundwater
Surface water
Soil
Air
Receptor Exposure
Land use
GW use
SW use
Population density
Regional Development Risk
Development time
Road
Residential area
Fundamental public facilities
Current residential area re-build
Land Use
Industry
Farming
Reserves
Public Affaires
Wildlife habitat
Final disposal
Special land demand
35

Strategy

- The project is still ongoing and the suspicious contaminations are marked.
- The remediation planning started once the contaminations were marked.
  - Priority list and review of regional land use
  - Combine risk assessment with green remediation
  - Brownfield redevelopment first without thorough cleanups
  - Increase land values, create regional economic growth, reduce governmental costs

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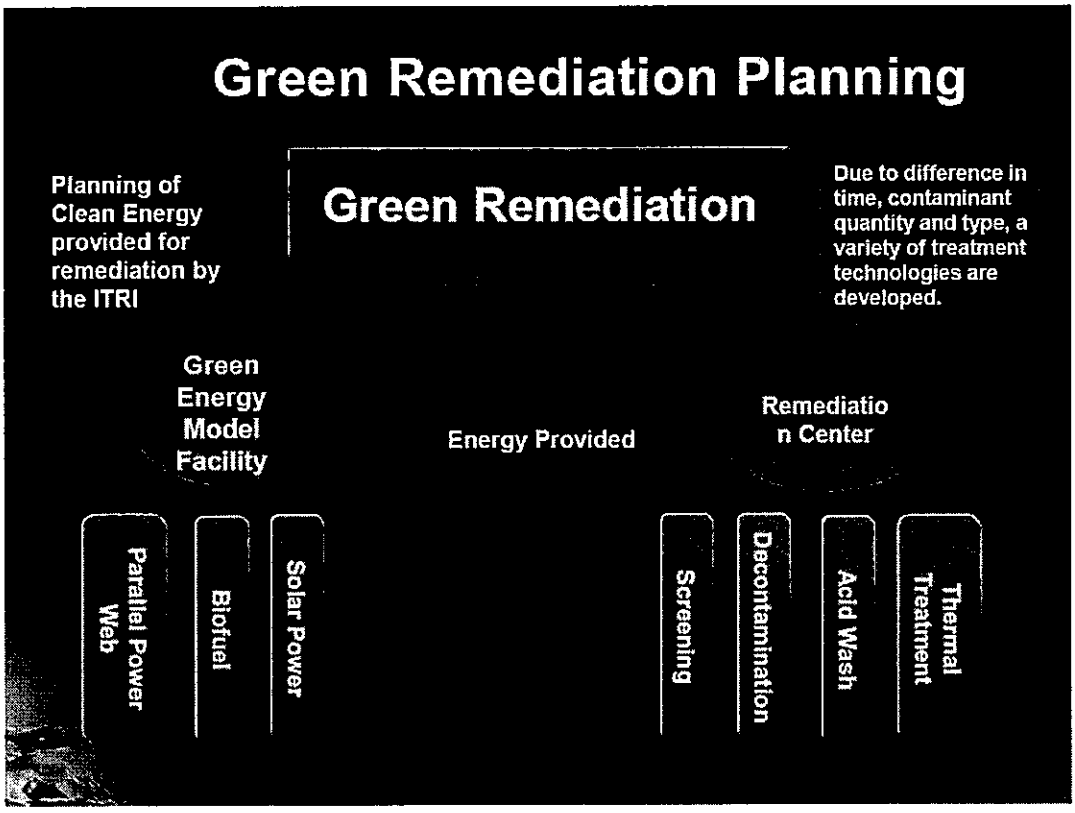
Clean-up Strategy Guidelines

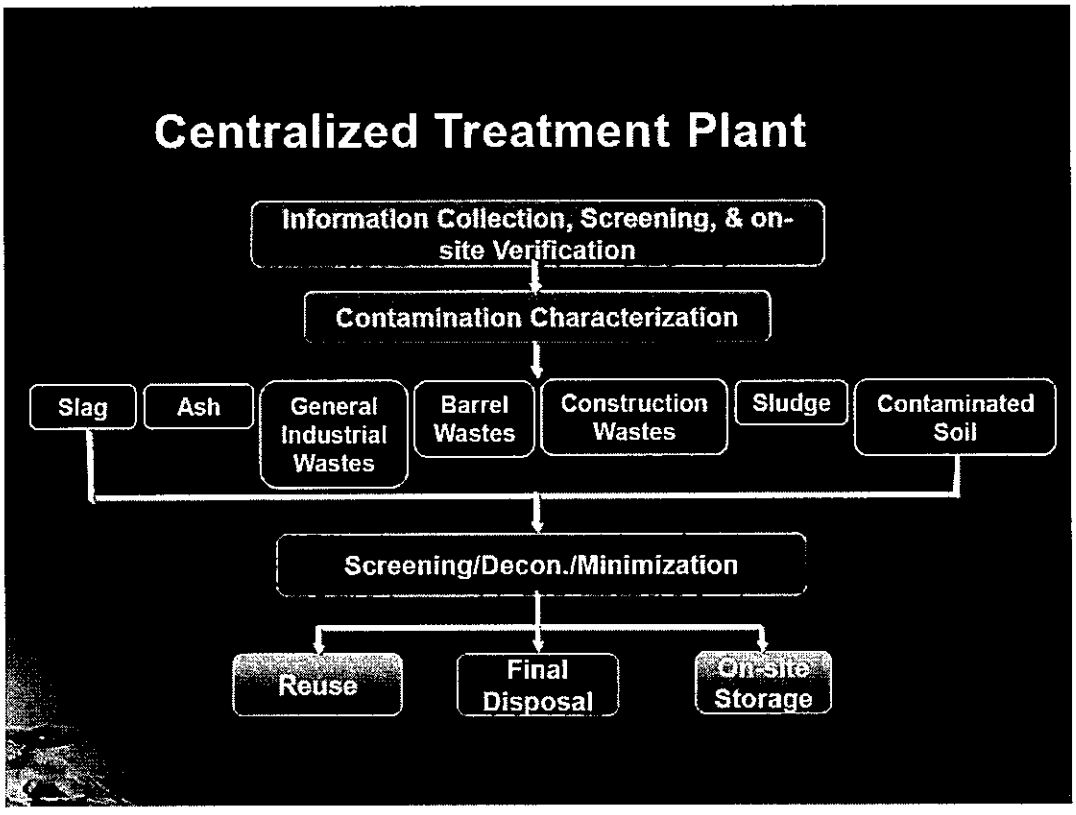
Reuse: recyclable screening, classification, and cleaning for on-site reuse

Low carbon cleaning: on-site cleaning and final disposal to lower energy use; green energy use

Decrease contamination area: centralized treatment

Remediation combined with Land Use: brownfields cooperated with private sectors


Green Remediation Planning
Planning of Clean Energy provided for remediation by the ITRI
Green Remediation
Due to difference in time, contaminant quantity and type, a variety of treatment technologies are developed.
Green Energy Model Facility
Energy Provided
Remediation Center
Parallel Power Web
Biofuel
Solar Power
Screening
Decontamination
Acid Wash
Thermal Treatment


Centralized Treatment Plant
Information Collection, Screening, & on-site Verification
Contamination Characterization
Slag
Ash
General Industrial Wastes
Barrel Wastes
Construction Wastes
Sludge
Contaminated Soil
Screening/Decon./Minimization
Reuse
Final Disposal
On-site Storage

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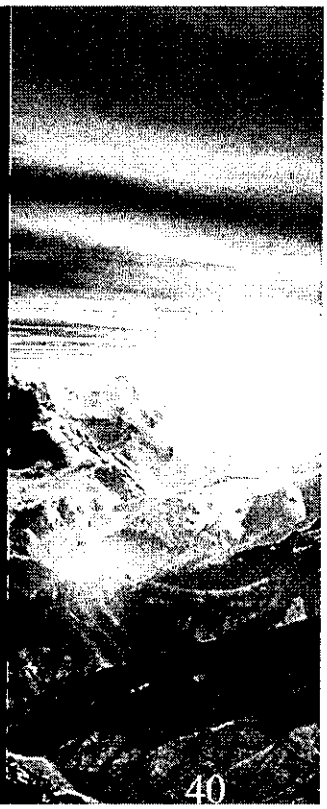
Combination with the Urban Planning of Kaohsiung City



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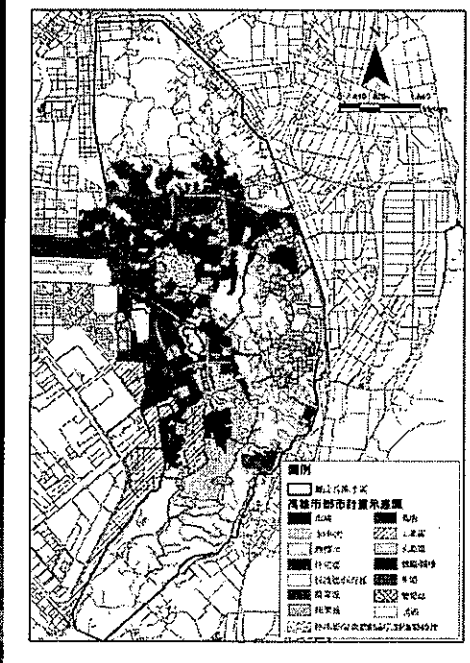
The 3rd Review of the Dapingding Area Redevelopment of Kaohsiung City



- The 3rd Review in 2011
- Incorporate contaminated lands into the urban plans. Redesign land use regions and satisfy the demands in land
- Encourage public investments on the remediation to increase the land values as the key consideration

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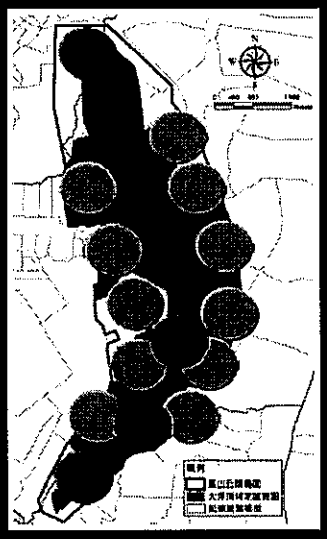
Vision of Dapingding Area Development

Target

- Green & Ecology
- Renewable Energy
- Smart Grid
- Green Building
- Green Transportation



Procedure

- Green Remediation Base
- Rebuilding the Space (Green belt & ecological protection)
- Green Transportation & Energy Use Planning

Low carbon area
Ecological protction
Mid-process Contaminant Treatment

Benefits

paradigm of green remediation and brownfield redamation

Establish regional industries to promote economical benefits

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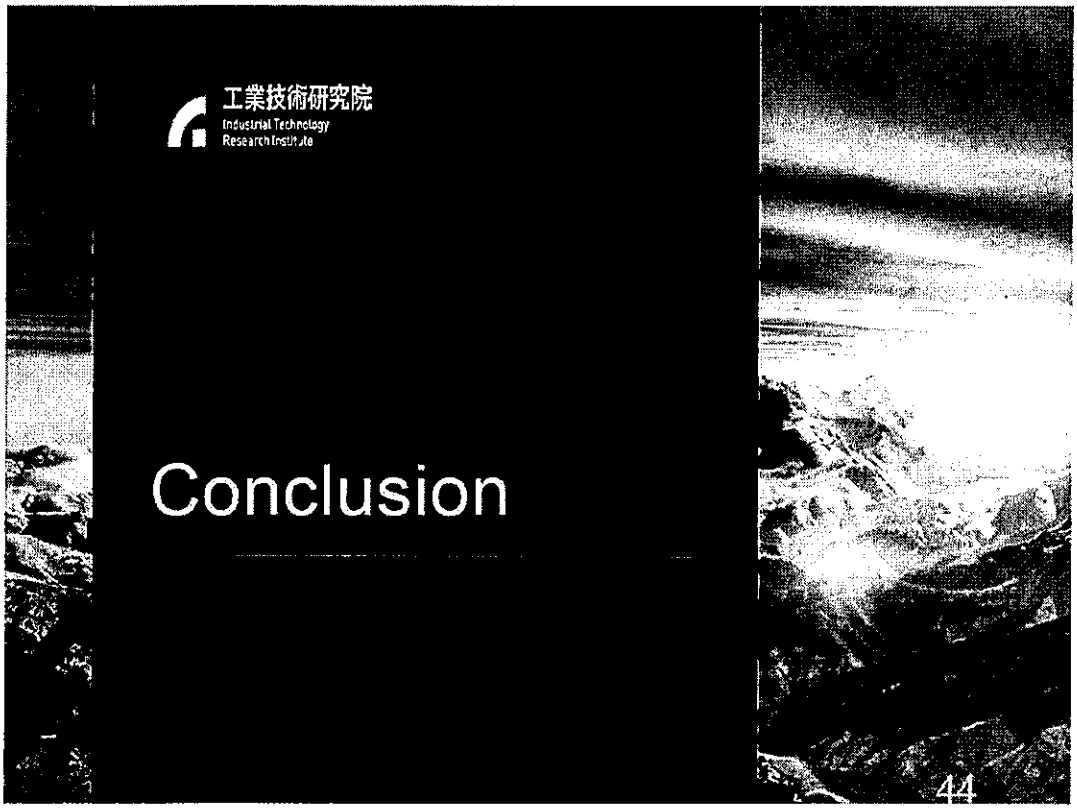

Barriers to Overcome

Restrictions in Law

Environmental laws, such as environmental impact evaluation and urban planning

Relative Limitations

Responsibility among relative responsible parties

Altitude of stakeholders and governmental compensation mechanisms

Communications with surrounding residents or environmentalists

Budget

Public investments or

Governmental funds (air pollution fund, soil & GW Remediation Fund, recycling fund) or

IPO

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Acknowledgements

The project is funded with the budget sponsored by the Environmental Protection Administration, Executive Yuan.

Thank You for Your Attention