行政院及所屬各機關出國報告

（出國類別：出席國際會議）

參加第二十四屆亞洲及國際遙感探測研討會報告

服務機關：經濟部水利署臺北水源特定區管理局
出國人　職稱：副工程司
姓名：黃琇蘭
職稱：工程員
姓名：魏俊生
出國地區：韓國釜山
出國期間：92 年 11 月 3 日至 92 年 11 月 7 日
報告日期：93 年 2 月 6 日

行政院及所屬各機關出國報告

（出國類別：出席國際會議）

參加第二十四屆亞洲及國際遙感探測研討會報告

服務機關：經濟部水利署臺北水源特定區管理局

出國人：職稱：副工程司

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出國期間：92 年 11 月 3 日至 92 年 11 月 7 日

報告日期：93 年 2 月 6 日

行政院及所屬各機關出國報告提要　　系統識別號　C09300598

出國報告名稱：參加第二十四屆亞洲及國際遙感探測研討會報告　頁數 32　含附錄：否

出國計畫主辦機關/聯絡人/電話

黃琇蘭/經濟部水利署臺北水源特定區管理局/污水處理課/副工程司/29173282

魏俊生/經濟部水利署臺北水源特定區管理局/水土保持課/工程員/29173282

出國類別：□1 考察 □2 進修 □3 研究 □4 實習 ■5 其他（出席國際會議）

出國地區：韓國釜山

出國期間：92 年 11 月 3 日至 92 年 11 月 7 日

報告日期：92 年 2 月 6 日

分類號/目：G0／綜合（各類工程）　G0／綜合（各類工程）

關鍵詞：遙感探測應用，水源保護，GIS，GPS

內容摘要：（二百至三百）

一、目的：宣揚我國將地理資訊、遙感探測運用水源區保護之執行績效，並藉國際學術交流吸收各國最新科技與經驗作爲本局施政之參考，且於大會發表「地理資訊系統輔助水源保護區污水下水道之管理」及「遙感探測、地理資訊系統及人造衛星定位系統應用於水質水量監測」等二篇論文。

二、過程：自 92 年 11 月 3 日至 92 年 11 月 7 日參加研討會及發表學術論文、與各國學者專家交流討論。

三、心得與建議：1.韓國具有多功能人造衛星，此項國際研討會有專題演講及兩場討論會以此衛星爲主題。擁有自己的人造衛星，是目前世界上工業大國的基本條件之一。我國將於 2004 年發射中華衛星二號，相關研究與應用可以急起直追。而行政單位遙感探測的應用，仍需加強。

2.此次大會我國參加人數比以前增多，但相對於中國大陸、日本、韓國仍差一大截。我國仍以大學院校、工研院爲主體，政府單位的技術人員，參加人數仍嫌少，反應出我國行政單位應用新科技的狀況，有落後日本、韓國、中國大陸之虞。

3.偏極化合成孔徑雷達(InSAR)對於數值高程的測製速度快、精度很高，據稱可達 1 公分以內之精度，對於國內灌溉排水所需高程精度需在 15 公分以內而言，已經符合需要。水資源管理方面的應用，亦可密切注意其後續應用之發展。

本文電子檔已上傳至公務出國報告資訊網

出國報告名稱：參加第二十四屆亞洲及國際遙感探測研討會報告

出國計畫主辦機關名稱：經濟部水利署臺北水源特定區管理局

出國人姓名/職稱/服務單位：(若二人以上，則列○○○等人)

黃琇蘭/經濟部水利署臺北水源特定區管理局/污水處理課/副工程司/29173282

魏俊生/經濟部水利署臺北水源特定區管理局/水土保持課/工程員/29173282

出國計畫主辦機關審核意見：

□1. 依限繳交出報告

□2. 格式完整

□3. 內容充實完備

□4. 建議具參考價值

□5. 送本機關參考或研辦

□6. 送上級機關參考

□7. 退回補正，原因：

□(1)不符原核定出國計畫

□(2)以外文撰寫或僅以所蒐集外文資料爲內容

□(3)內容空洞簡略

□(4)未依行政院所屬各機關出國報告規格辦理

□(5)未於資訊網登錄提要資料及傳送出國報告電子檔

□8. 其他處理意見：

目次

壹、 目的

第二十四屆亞洲及國際遙感探測研討會（ACRS2003ISRS）訂於九十二年十一月三日~十一月七日在韓國釜山舉行，本次大會主題含有－高解析度影像應用、災害監測和管理、環境監測、數值高程製作、森林資源保育、水資源保育與水質監測、土地利用、災害監測與管理等；其討論主題與本局歷年來執行水資源保護工作（如水土保持、造林、土地使用、水質水量保護、使用分區規劃、集水區經營等）所運用之地理資訊系統、衛星定位、衛星影像遙感探測、數值地圖資料庫等最先進科技息息相關。為宣揚本局將地理資訊系統結合遙感探測運用於水源區保護之績效，並藉國際學術交流吸收世界各國最新科技及研討技術與經驗作為本局施政之參考，本局將受邀於會中發表「地理資訊系統輔助水源保護區污水下水道之管理(Implementations of Geographic Information Systems on Sewage Management for Water Resources Protection)」及「遙感探測、地理資訊系統及人造衛星定位系統應用於水質水量監測(Implementations of Remote Sensing, GIS, and GPS for Water Resources and Water Quality Monitoring)」等二篇論文，由副工程司黃琇蘭及工程員魏俊生代表本局參加該國際研討會，期能透過與世界各國學者專家在地理資訊系統業務應用科技問題上相互交換經驗與心得，以增進水資源保護與經營管理之成效。

有鑒於本局為國內唯一執行集水區水資源保護、經營管理機關，且歷年來執行績效卓著，與使用地理資訊系統、電腦圖等最先進科技有極大之助益，故有必要藉本次國際研討會宣揚本局將網際網路地理資訊運用於水

源區保護及相關經營管理經驗，供世界各國參考。並可藉國際學術交流機會，與世界各國不同領域之學者專家做雙向溝通討論，期能吸收世界各國最新研究技術與經驗，作爲本局施政之參考。

貳、過程

應邀參加第二十四屆亞洲及國際遙感探測研討會論文發表行程表

日期	起迄地點	內容	停留天數
92.11.3	本局→中正機場→韓國濟洲島	由臺灣搭機至韓國濟洲島預備轉機至釜山	1
92.11.4	韓國濟洲島→韓國釜山	轉機至釜山參加研討會	1
92.11.5~92.11.6	韓國釜山	參加研討會及發表論文	2
92.11.7	韓國釜山→韓國濟洲島	研討會結束搭機至濟洲島預備轉機回臺灣	1
92.11.8	韓國濟洲島→中正機場	由濟洲島搭機回臺灣	1

參、研討會重要內容

一、 研討會名稱：第二十四屆亞洲及國際遙感探測研討會

(The 24th Asian Conference on Remote Sensing & 2003 International Symposium on Remote Sensing)

二、 大會日期：自民國 92 年 11 月 3 日 至 民國 92 年 11 月 7 日

三、 開會地點：韓國釜山市國際展覽及會議中心

四、 主辦單位：

1. 亞洲遙感探測學會

2. 韓國遙感探測學會

3. 東亞太空環境監測委員會

五、 贊助單位：

1. 國科學學會

2. 資訊科技學會

3. 韓國科學發展基金會

4. kookmin 大學

5. 韓國太空科學院

6. 電子與通訊研究院

7. 韓國大氣及礦物研究院

六、 亞洲遙感探測國際研討會歷史：

第 1 屆至第 24 屆大會分別在不同國家舉辦,1980 第一屆地點爲

泰國曼谷,依續爲：

屆別	年	主 辦 國 家	地　　點
1	1980	泰國	曼谷
2	1981	中國	北京
3	1982	孟加拉	達卡
4	1983	錫蘭	可倫坡
5	1984	尼泊爾	加德滿都
6	1985	印度	海德拉巴
7	1986	韓國	漢城
8	1987	印尼	雅加達
9	1988	泰國	曼谷
10	1989	馬來西亞	吉隆坡
11	1990	中國	廣州
12	1991	新加坡	新加坡
13	1992	蒙古	烏蘭巴托
14	1993	伊朗	德黑蘭
15	1994	印度	班卡洛
16	1995	泰國	納可拉加西瑪
17	1996	錫蘭	可倫坡
18	1997	馬來西亞	吉隆坡
19	1998	菲律賓	馬尼拉
20	1999	中國	香港
21	2000	中華民國	台北
22	2001	新加坡	新加坡
23	2002	尼泊爾	加德滿都
24	2003	韓國	釜山
25	2004	土耳其	伊斯坦堡

七、　論文發表概況：

全部共有來自 25 國家地區 500 篇科學論文。全部投稿論文摘要計

有 700 篇，篩選出 500 篇論文，其中 320 篇爲口頭報告，分爲 70 場次；180 篇以壁報交談式展示。

(一)論文分類如下：

類別	百分比(%)
遙感探測應用	39.6
資料處理	21.7
新式掃瞄機	13.7
地理資訊系統	20.1
人造衛星定位系統及航測	4.9
合計	100

(二)討論主題：

1. 影像分類
2. 視頻影像
3. 空載掃瞄
4. 大氣
5. 影像定位
6. 公共健康
7. 都會區應用

8. 環境監測

9. 海洋監測

10. 數值高程製作

11. 立體展示

12. 影像融合

13. 影像特徵自動粹取

14. 海岸線製圖

15. 決策支援系統

16. 變化監測

17. 森林資源保育

18. 地理資訊系統與遙感探測整合

19. 農業

20. 土地利用

21. 地質

22. 干擾與偏極合成孔徑雷達

23. 地理資訊資料處理

24. LIDAR 資料處理

25. 航測軟體製圖

26. 空間資料基礎架構

27. 高解析光譜資料處理

28. 商業與私人企業可用之地理資訊系統

29. 氣象

30. 災害監測與管理

31. 數值正射像片圖製作

32. 韓國人造衛星

33. 製圖系統

34. 生態系監測

35. 洪災製圖與監測

36. 水資源保育與水質監測

37. 自然資源管理

(三)大會專題演講：

主講人：韓國太空科學院 Hong-Yul Paik

講題：韓國之太空發展

KOMPSAT：韓國多功能人造衛星(Korean mult-purporse Satellite)

探討主題如下：

1. 高解析度衛星影像資料融合

2. KOMPSAT-1 衛星軌道參數之精確度評估

3. 遙感探測影像雜訊移除；KOMPSAT OSMI 資料應用範例

4. 多光譜掃瞄機之系統設計

5. 漸近式混合密度估測與截取法應用於非監督式變化監測

6. 數種空間解析度農業資訊系統架構之標準化

7. IKONOS 高解析度衛星影像應用於松樹受害情況調查

8. KOMPSAT-2 衛星模擬影像應用於山區墳墓調查

9. 衛星光電電荷偵測器的控制系統設計

10. 高解析度海洋太空感測器光譜反射與海洋水色模擬

11. 衛星遙測應用於紅潮偵測

12. 東亞地區大規模空氣污染的衛星監測

(四)專題講習-1

空間資料融合原理與趨勢

空間資料越來越多，資料量與品質皆快速增加。由單一感測儀器所獲取資訊不若多種感測器所獲得的訊息，況且新資訊常需與舊資訊及舊地圖套疊來比較分析。地理資訊系統應用之第一步為空間資訊套疊融合。有越來越多不同資料可供選擇，資料內涵更為豐富，所以，資料事前的處理需要更多的步驟。探討主題包括：

1. 間資料融合基本定義

2. 空間資料特色

3. 前期處理方法與基本要件

4. 資訊數值化與標準化

5. 偏極合成孔徑雷達資料融合的特殊考量

6. 資料融合數學函數

7. 理想空間資料融合方法

8. 誤差傳播與分析

9. 最後結果的虛擬展示

(五)專題講習-2

由雷達偏極到偏極化合成孔徑雷達的干擾特性及其應用，分爲五大主題：

1. 雷達偏極基本原理

2. 偏極化合成孔徑雷達的干擾、斷層掃瞄、全像攝影

3. 雷達偏極與偏極化合成孔徑雷達之應用

4. 雙向靜態干擾合成孔徑雷達在太空之應用

5. 遙感探測爲地球偵測及地球病理學之工具

(六)衛星影像應用於水庫淹沒區之重建

摘要：對因建造大水壩而失去家園的人來說，能恢復的到原狀是非常美好的事情。本文針對Cheung-Pyung淹沒區(1980年因Chungju大壩而淹沒的地區)研究以遙測技術應用3D的效果，重建未淹沒前的地形。我們收集精密的人造衛星照片和數位遙測影像製造淹沒前的地表地形彩色影像。這項任務需拼湊二種不同時間的像片。然後，產生淹沒區等高線(包括近郊)的數值高程(DEM)地圖。它將會製成Cheung-Pyung附近完美3D影像，包括所有方位-北方、南方、東方和西方角度透視圖展示，類似低空巡視的飛行模擬能使我們體驗在那兒的真實感覺。

關鍵字:影像重建，DEM，透視圖法形象，Cheung-pyung Myung-wol，Chungju水壩

1.前言

今天Cheung-Pyung湖附近已經成爲觀光勝地，在附近看得見大湖和美好景色及建造Cheung-Pyung文化中心、旅館、戲劇攝影棚、韓國最大的噴泉、水上飛機和公寓大廈等。然而假如我們提到此地的以前就令人難過，長久以來，此地是非常有文化傳承的意義，如同"Cheung-Pyung-Myung-Wol"的雄鹿一般。但它在1985年Chungju-水壩完工後，造成25個村莊，1,665間房子淹沒於水中。 對於原本約9,500人居住在那裡並被迫遷移到其他的市(鎮)的人

而言，現在他們只可在夢中看到他們的家鄉。因此，以電腦科技重建他們過去的生活空間是意義深長的工作。爲了收集淹沒前有關文件和地圖並整理製成1985年以前的地籍圖和地形圖，首先，我們參觀當地相關政府機構、水資源公司、建設公司和地區的文化中心，並再搜尋人造衛星照片和遙測數位影像圖。爲了重建過去被洪水所淹沒的地形，我們設置目標區域並重建彩色的3D影像，盡可能的製作飛行模擬，詳細的過程如下。

2.目標區分析和準備

目標區 Cheung-Pyung 地處 Jecheon。過去這裡是 Cheung-Pyung 市(鎮)的一部份，包含了 9 個村莊，1995 年經由政策的整合成 Cheung-pyung 縣市。這整個淹沒區域約 5,643,000 pyeong 其中包含 25 個鎮在內的耕地、農場、森林和其它地區。其中 Cheung-pyung 有 50%是被淹沒的。

爲了做出這地形圖，需要任何淹沒前的市(鎮)圖(照片)和資料，我向相關機構索取遙測照片、人造衛星照片和人造衛星數位影像。我們拜訪了管理 Chungju 水壩的 Chungju 韓國水資源開發公司取得了一些資訊。但那裡除了一些有關於這水壩的圖片和資訊外，也只有少部份的"淹沒市(鎮)歷史"。所以，我們沒辦法獲得任何詳細地文件、地形圖和照片。我們在這計畫的基礎工作只好經由在這博物館中心的市(鎮)模型和國家地理局 1984 年繪製出版的 1/50000 的地圖開始.

首先，經由地形圖的比對，整理手上淹水前後城市照片，然後，以小型掃瞄機掃瞄。因此就能在電腦裡看到市(鎮) 圖。然後我計劃以後用人造衛星照片影像資料來做合併及編輯。

爲了取得遙測影像圖我向漢城國立大學的太空資訊實驗室索取到由美國國家航空暨太空總署管理的 Landsat-3 TM 衛星的 7 個波段數位影像圖，那是 1984 年二月後唯一剩下的資料。幸運的是，我還有 Corona 衛星 1969 年的衛星照片，並決定使用 Landsat-4 及 Ikonos-1 衛星於水災後拍攝的人造衛星照片資料。

3. 合併影像的產生和選擇最適合的合成圖像

我決定分離該區平均海平面上方 80M 到 150M 間的等高線。我掃描國家地理局複製的原始圖以製作等高線，然而無法看清線路而且無法用任何繪圖軟體來編輯，以致無法使用。

1969 年的 conona 衛星照片是黑白的掃瞄圖，有 5m 到 10m 地面解析度。Landsat-TM 衛星多波段影像有 28.5m 解析度。如能從他們得到合成圖，解析度應可達到 10-15m。因此，爲了此合成圖而須改變二種不同時間的圖像資料製成新資料格式，如此將會有未修正的扭曲影像問題。合成前用精密幾何學修正成最低限度位差，應可事先解決這問題。特別是，關於這人造衛

星照片沒有任何人造衛星資訊，因此套疊相互位置需利用人造衛星的高度和天氣狀況(更進一步改正過程不在這報告的範圍內)。本專題僅試著以精密幾何學從 Corona 衛星影像和 TM 衛星影像去處理產生合成圖(此二個種類的影像有 15 年的時間差異)。從不同波段影像及經度創造出新圖的結果非常令人興奮。結果如下

圖1. Corona69和TM1/2/3波段合成圖

圖2. Corona69和TM1/3/5波段合成圖

圖 3. Corona69 和 TM1/2/7 波段合成圖

圖 4. Corona69 和 TM1/3/7 波段合成圖

合成圖 3 最能顯示這地帶詳細的地形和村莊，有助於製作下一個 3D 影像。

4. 3D透視圖的產生和模擬

假如你想有 3D 的透視圖像，需選擇最適合的影像及 DEM 的資料去融合二者，圖像的解析度需相同，否則不能有好的 3D 透視影像，觀察位置高度

太高或太低也不能有好的 3D 透視圖。本研究決定以 5:1 比例的水平線及垂直線進行合併。另需經由適當的角度、方向、遠或近和適當的情況定出不同標的區的標準投射角和坡度以決定地形狀況。然後作出每個方向(北方、南方、東方和西方)的 3D 透視圖。

圖5.透視圖1以角度60度和坡度30度從遠到近跨越東方到西方

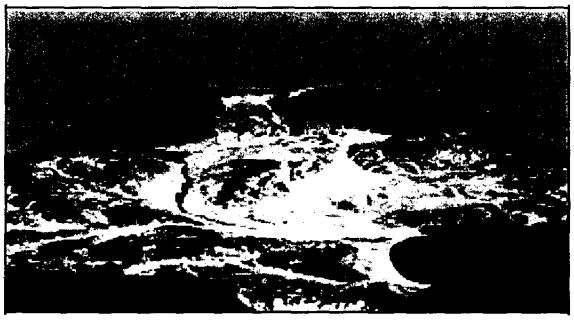

圖6.透視圖2以角度60度和坡度25度從遠到近跨越西方到東方

圖7.透視圖3以角度60度和坡度35度從遠到近跨越南方到北方

圖8.透視圖4以角度用60度和坡度30度從遠到近跨越北方到南方

接下來爲了3D的航空模擬，須加入速度變化、高度變化和坡度變化和飛行狀況到資料圖像內，我使用DEM資料和最好的合成圖，並決定飛行的路徑。我使飛行模擬能經由任何的速度、高度、坡度來顯示整個Cheung-Pyung淹沒區。

5. 心得和總結

首先我對這研究感到滿意，因可經由上述遙測技術將淹沒區的地形還原，我認爲若能再加入紅外線遙測技術，結果會更好。這對遺失他們的家園的人而言是非常意味深長的。應用3D遙測技術做出飛行模擬，經由電腦製作呈現消失在這真實世界的夢境，可讓遺失家園的人們減輕他們的悲痛。

第二，合成圖像前需努力到找尋每一個部份土地空間資訊和資料，以

了解本身儲存多少土地空間資訊和資料以製作國家地理空間圖。然後，不應僅止於將遙測資料製成照片和數位影像，應盡一步分析它融入所有過去的資料包括文化和生活方式，製作出新影像。

第三，3D影像會比2D資料更容易表示真正的地理空間資訊。此工作需要所有的學術和研究單位努力積極地支援。

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(七)地面光譜儀與 SPOT 影像應用於水質估測

摘要：本研究利用SE-590地面光譜輻射儀(Spectroradiometer)量測水體的光譜輻射強度；並在近於同一時間量測標準白板的輻射強度，換算爲反射率後，再與同步取樣的水質檢測資料施行多元迴歸分析(multiple regression)，並評估回歸統計結果。研究中除配合水樣分析定量推估葉綠素A、懸浮固體與透明度等三種水質物理參數外；亦模擬SPOT衛星三個波段波長的輻射值與檢測水值資料進行迴歸分析。另外以德基水庫爲例，比較同一天的水質檢測與SPOT衛星影像光譜資料統計分析結果；並藉由SE-590模擬SPOT衛星三個波段得到的光譜資料，建立SE-590、SPOT資料及SE-590模擬POT衛星光譜資料的回歸方程式，再定量推估水質分佈。初步統計回歸分析推估結果，以SE-590建立的回歸方程式推估資料最佳，其推估葉綠素A、懸浮固體與透明度標準差爲分別爲0.57 ug/l, 0.2 mg/l and 0.17 m。

關鍵字:遙感，地面光譜輻射儀，水質，營養狀況

1. 前言

傳統上評估蓄水庫或一河川的污染狀況都用平均分配採樣點來估算其卡爾森指數(CTSI)，生化需氧量/需氧量比率法，等等... 然而，取樣位置是有限的，無法代表真正的水面水質。而另一方面遙測影像可經由建立統計回歸分析模式結合取樣資料估算整個水面水質。這模式可應用在遙測影像

評估包括葉綠素A、透明度、 懸浮固體(SS)、濁度和溫度。根據美國的EPA標準，假如葉綠素A濃度大於12ug/l，透明度少於2m，則水質屬優氧狀態。

本研究則使用手提式SE-590地面光譜輻射儀(波長:0 .373~1 .107um)以量測水體標準的白板輻射。然後，量測水體反射比並分析反射特性，並建立回歸分析模式對照出葉綠素A，透明度和懸浮固體。本文研究範圍爲中台灣德基水庫，使用同一天的SPOT衛星影像，同時也以SE-590模擬SPOT衛星光譜帶，收集水面光譜的資料以作爲往後的分析。

2. 遙測分析法

2.1 以遙測分析取得的水質

每個污染物或污染源都有它們自己的獨特光譜特性。譬如，水中SS增加則反射比將上升，光譜曲線轉變到長波長。不同污染物也會將上述特性反映在這遙測影像上。

水體輻射受以下因素影響，它們是：(1)能源，例如：日光和鏡頭穿透率；(2)大氣影響，例如：散射和吸收；(3)表面反射，例如：包括日光和鏡頭反射；(4)反射量，例如：清水和其他污染物的合併效果；(5)底部反射，例如：電磁波從底部反射。

在五個因素中, 水質經由遙測分析而言反射量是最重要的因素。當使用於影像像素相同時能源是影響最小的。假如水深大於遙測光譜的穿透深

度，底部反射則只有少許的影響。再者，這大氣影響效果可以被忽略，因爲SE-590感應器僅用在水表面1公尺的上方。根據這些狀況，使用取樣資料和遙測影像就可利用統計學模式來預估水質的分布。

2.2 統計學的迴歸分析

水質參數和多重光譜資料的關係是使用線性多元迴歸分析模式：

$$Y = X\beta + \Sigma$$

Y：被評估的水質，X：多重光譜矩陣，Σ：隨機誤差

β：迴歸係數，$(X'X)^{-1}X'Y$是β的最小平方解。

SE-590資料的252的波段將會使用太多電腦時間去建立線性多元迴歸分析模式。所以，從380到950nm的光譜範圍裏17個波段被選爲更進一步統計學上的分析用。

階梯式的多元迴歸分析模式被使用在預測水質時取得最佳的波段。嚴格統計學的參數標準是被設定用來評估水質，他們是：(1)相關迴歸係數是近於1；(2)標準誤差值是近於0；(3) f -test到f(0 .05)的比率是≧4.0；(4)這統計量ti是≧2 .0；(5)計算標準期望值總誤差(Ck)很小且比率Ck/(k+1)≦1 .0，k是係數的數量。

當統計迴歸分析模式選定後，多樣的影像和水樣資料可輸入迴歸分析模式以估算迴歸係數並繼續估算水質參數的葉綠素A，SS和透明度。最後，

這計算結果是被用來比較水樣與取樣點的真實度來估算標準誤差值RMS。

圖1是水質評估流程圖.

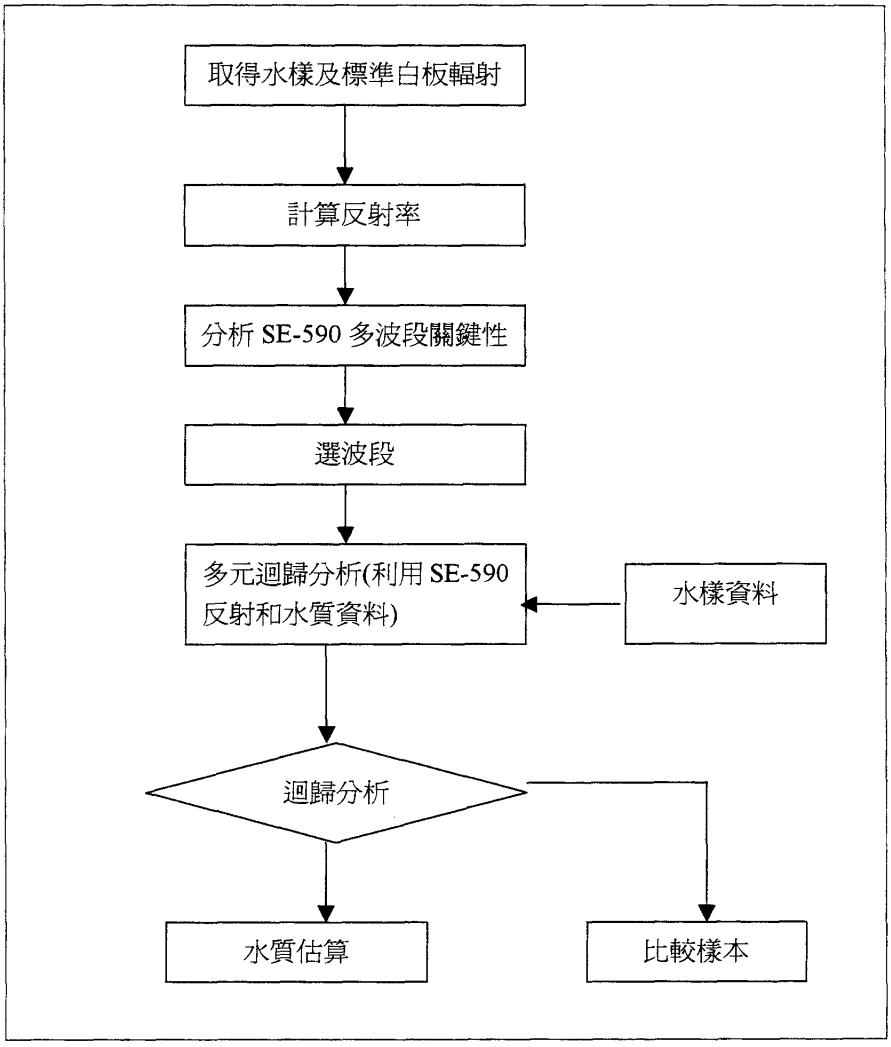

圖1.水質評估流程圖

3. 結果

SE-590模擬SPOT衛星光譜資料，經使用統計學的迴歸分析模式用來評

估葉綠素A，SS和水表面的透明度。

3.1 迴歸分析的結果

SE-590資料的迴歸分析結果如表一。迴歸係數>0 .99，所有的 f -test到f(0.05)的比率也是≧4.0，對葉綠素A，SS和透明度，所有的Ck/(k+1)≦1.0。SPOT衛星影像取得的迴歸係數小於SE-590所得到的，特別是對透明度來說只有0.75。不論如何，SE-590模擬SPOT衛星光譜波段得到較好的係數，例如0.91。

上述RMS誤差值也是被討論。SE-590量測SS及透明度的RMS誤差值小於其他。不論如何，模擬SPOT波段對葉綠素A的評估是最差的，RMS誤差值是1 .77ug/l。

3.2. 取樣點的標準誤差

取樣點的標準誤差如表二。此RMS的誤差值比線性回歸分析的結果還差。SE-590量測SS的標準誤差是3.50mg/l，其經由模擬SPOT波段的葉綠素-a的估計值是2.96ug/l。此使用SE-590模擬SPOT衛星波段的評估水質如圖2。

表 1. 使用多樣資料的迴歸分析結果

SE-590反射係數資料					
水質	迴歸係數	標準誤差	F-test	F(0.05)	C k/(k+1)
葉綠素A	0.9949	0.57 ug/l	139.33	3.14	0.06
懸浮固體	0.9947	0.2 mg/l	28.90	5.90	0.80
透明度	0.9946	0.17 m	38.30	4.68	0.78
SPOT衛星影像					
葉綠素A	0.9273	0.36 ug/l	24.56	3.41	0.76
懸浮固體	0.9025	0.49 mg/l	19.02	3.49	1.0
透明度	0.7534	0.42 m	19.69	3.59	0.05
SE-590模擬SPOT衛星光譜波段					
葉綠素A	0.9321	1.77 ug/l	28.72	3.41	1.0
懸浮固體	0.8980	0.49 mg/l	16.66	3.49	1.0
透明度	0.9050	0.37 m	16.59	3.59	1.0

表2.採樣點誤差

採樣點	葉綠素A (ug/l)		懸浮固體(SS) (mg/l)		透明度 (m)	
	量測值	預估值	量測值	預估值	量測值	預估值
	SE-590反射係數資料					
3	1.9	1.94	0.8	5.13	3.9	2.0
11	2.2	3.95	1.0	2.9	3.35	1.54
15	1.3	2.95	1.6	4.96	3.30	3.97
20	4.5	2.39	1.0	4.29	2.75	2.29
22	4.1	4.96	1.8	2.09	2.75	0.20
RMS	1.48		3.50		1.67	
	SPOT衛星影像					
3	1.9	2.22	0.8	0.02	3.9	3.95
11	2.2	2.06	1.0	0.11	3.35	3.95
15	1.3	2.95	1.6	1.14	3.3	3.31
20	4.5	2.73	1.0	0.67	2.8	3.21
22	4.1	2.33	1.8	0.68	2.8	3.42
RMS	1.35		0.72		0.41	
	SE-590模擬SPOT衛星光譜波段					
3	1.9	2.3	0.8	2.6	3.9	3.7
11	2.2	7.4	1.0	3.7	3.35	3.0
15	1.3	0.1	1.6	1.5	3.3	4.2
20	4.5	4.5	1.0	2.7	2.75	3.3
22	4.1	0.2	1.8	1.3	2.75	3.7
RMS	2.96		1.44		0.66	

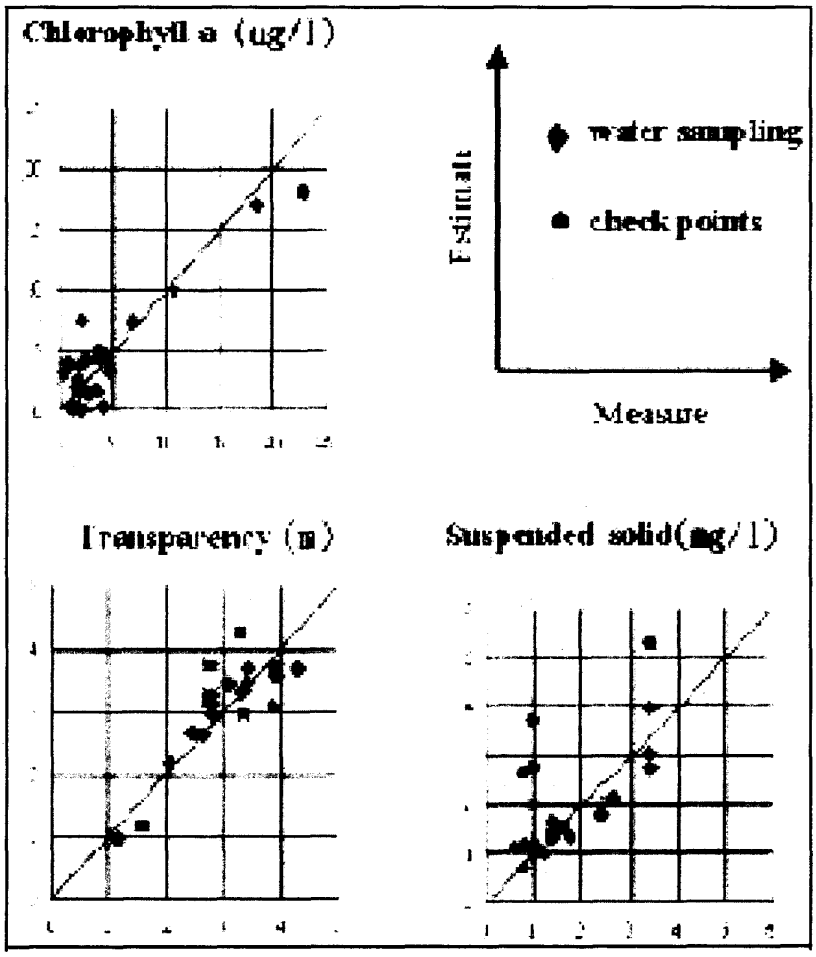

圖 2.量測值和預估值的水質分佈

4. 結論和討論

SE-590量測過的反射係數資料及SPOT衛星影像和SE-590模擬SPOT衛星波段是被用來做水質的評估，結論如下：

(1)SE-590，SPOT衛星影像，SE-590模擬SPOT衛星光譜波段來分析水質

參數，可利用階梯式的多元迴歸來取得最佳的預測模式，統計學上的標準包括高迴歸係數，低標準誤差，f-test，及統計值(ti)和Ck/(k+1)，等等。它顯示所有水質參數的迴歸超出預測模式的基本要求。

(2)大體而言，經由SE-590模式所得到的葉綠素A，SS和透明度的標準誤差評估值是最佳的推算資料，其數值分別是0.57ug/l，0.2mg/l和0.17m。經由SPOT資料所得的誤差值分別爲0 .36ug/l，0.49mg/l和0.42m。而SE-590模擬SPOT衛星光譜資料所得的RMS誤差值最差，分別是1 .77ug/l，0.49mg/l和0.37m。

(3)不論如何，經由SPOT衛星影像及模擬SPOT衛星光譜波段所預測得到5個採樣點的SS及透明度的標準誤差值是小於SE-590。這可能是因爲廣濶的帶寬及SPOT波段的平均效果。

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八、 本局發表之論文：

本局發表論文題目爲「地理資訊系統輔助水源保護區污水下水道之管理(Implementations of Geographic Information Systems on Sewage Management for Water Resources Protection)」及「遙感探測、地理資訊系統及人造衛星定位系統應用於水質水量監測(Implementations of Remote Sensing, GIS, and GPS for Water Resources and Water Quality Monitoring)」等二篇論文，論文中文摘要如後：

地理資訊系統輔助水源保護區污水下水道之管理

伍木林　　陳久雄　　周文祥　　黃琇蘭

摘　要

經濟部水利署台北水源特定區管理局主要職掌為水源區水質、水量之保護與保育，永續供應大台北地區高品質之用水。轄區內已建置兩大污水處理系統，能夠收集兩集水區內之污水，分級處理後，無害排入河流。家庭廢水之處理率已超過 82%。偏遠地區住家廢水收集與處理，則需更周延策略與方法。本文目的是整合應用地理資訊系統，提供簡易又有效率之污水下水道管理方法。使用套裝軟體 ArcIMS 作為網際網路伺服器，因此可用個人電腦與筆記型電腦，隨時取用污水下水道相關地圖、設計圖或資料。野外現場則用套裝軟體 ArcPAD，配合個人數位助理(PDA)及其配件，如：數位相機、人造衛星定位系統。地圖與設計圖需先轉換為 ArcMap 格式，方能進一步使用。污水下水道管理應用模組之開發，使用 BASIC 程式語言及 ArcMap 專用程式物件 MapObjects，期能符合管理人員個別業務需要。網際網路資料庫之讀取與更新，引用 ASP.NET 程式語言。野外現場及個別居家污水管理，則為走動式地理資訊系統之一環。偏遠地區未納戶管理可使用個人數位助理(PDA) 、數位相機、人造衛星定位系統。整合地理資訊系統、人造衛星定位系統、個人數位助理提高污水下水道管理之效率，結合 ArcIMS、 MapObjects、 ASP.NET 以及 BASIC 程式污水下水道管理可在辦公室區域網路及網際網路上執行。

註：本文已被接受將發表於民國九十二年十一月三至七日於韓國釜山市舉辦之第二十四屆亞洲及國際遙感探測研討會。

遙感探測、地理資訊系統及人造衛星定位系統應用於水質水量監測

伍木林　　陳久雄　　劉秀鳳　　魏俊生

摘　要

經濟部水利署台北水源特定區管理局的水質水量監測，為每天例行工作，亦為長期努力目標。主要目的是永續供應大台北地區高品質之飲用水。大台北地區飲用水之品質為全島前茅。全部轄區有 717 平方公里，區內水污染源簡分為兩類：點狀與非點狀。垃圾為水污染重要來源，尤其是週末與例假日遊客所留下垃圾。非點狀污染源為殺草劑、肥料及其他自然污染。本文目的是應用遙感探測、地理資訊系統及人造衛星定位系統(GPS)輔助水質水量監測。本局轄區內設置 12 個水質監測站及 6 個河川流量監測站。18 個監測站使用 GPS 標定座標，標示於轄區圖上。使用 MapObjects 程式物件及 BASIC 程式開發應用模組。水質水量監測數據需公佈於網際網路，一般民眾可查詢瀏覽。過往 18 年監測資料及相關統計圖表亦可上網查詢。使用 GPS 標定垃圾子車及垃圾桶座標，連同垃圾收集清運路線圖建置於轄區圖上，因此地理資訊系統及人造衛星定位系統可應用於垃圾收集清運管理。圖檔格式為 ArcMap，個人數位助理(PDA)及 GPS 搭配數位相機，可以強化垃圾收集清運管理工作，有效調配清潔工作人員。台北水源特定區水質水量監測工作，可在網際網路及個人數位助理上執行。

註：本文已被接受將發表於民國九十二年十一月三至七日於韓國釜山市舉辦之第二十四屆亞洲及國際遙感探測研討會。

肆、心得與建議：

一、 韓國具有多功能人造衛星，此項國際研討會有專題演講及兩場討論會以此衛星爲主題。擁有自己的人造衛星，是目前世界上工業大國的基本條件之一。我國將於 2004 年發射中華衛星二號，相關研究與應用可以急起直追。而行政單位遙感探測的應用，仍需加強。

二、 此次大會我國參加人數比以前增多，但相對於中國大陸、日本、韓國仍差一大截。我國仍以大學院校、工研院爲主體，政府單位的技術人員，參加人數仍嫌少，反應出我國行政單位應用新科技的狀況，有落後日本、韓國、中國大陸之虞。

三、 偏極化合成孔徑雷達(InSAR)對於數值高程的測製速度快、精度很高，據稱可達 1 公分以內之精度，對於國內灌溉排水所需高程精度需在 15 公分以內而言，已經符合需要。水資源管理方面的應用，亦可密切注意其後續應用之發展。

伍、附錄：

附錄一：會議議程

ACRS 2003 ISRS - Schedule

	Room No.	A - AM1 (8:50-10:10)	B - AM2 (10:30-12:10)	C - PM1 (13:30-13:10)	D - PM2 (15:30-17:30)
3-Nov M	201	Tutorial Workshop 1 : Meta Data for Remote Sensing Data (Mark Becker, Columbia University. USA)		**Plenary Session**	
	202	Tutorial Workship 2 : Polarimetric and Interferometric SAR (W.M. Boerner, Univ. of Illinois-Chicago, USA)			
	203	Tutorial Workship 3 : Spatial Data Fusion Theory and Trends (W. Moon, Seoul National Univ., KOREA)			
	204	Special session 1 : Digital Asia Network (R. Yokoyama, ACRoRS - AIT)			
	207	Special session 2 : ASTER and PALSAR (H. Watanabe, ERSDAC, JAPAN)			
4-Nov T	201	TA1-Image Classification 1	TB1-GPS Application 1	TC1-Image Fusion	TD1-Forestry 1
	202	TA2-Video Imaging	TB2-Urban Application 1	TC2-Automatic Feature Extraction 1	TD2-Integration of GIS and Remote Sensing 1
	203	TA3-Airbone Sensing 1	TB3-Environmental Monitoring 1	TC3-Coastal Zone Mapping	TD3-Agriculture 1
	204	TA4-Atmosphere	TB4-Ocean Monitoring 1	TC4-Student Forum	TD4-Land Cover/Land Use 1
	207	TA5-Image Registration	TB5-DEM Generation	TC5-Decision Support System 1	TD5-Geology 1
	208	TA6-Public Health	TB6-Visualization	TC6-Change Detection	TD6-Interferometric and Polarimetric SAR 1
	2nd Floor Lobby			Interactive Session (TINT1)	

	Room No.	A - AM1 (8:50-10:10)	B - AM2 (10:30-12:10)	C - PM1 (13:30-13:10)	D - PM2 (15:30-17:30)
5-Nov W	201	WA1-Image Classification 2	WB1- Forestry 2	Tour	
	202	WA2-GIS data processing 1	WB2- Agriculture 2		
	203	WA3-Lidar Data Processing	WB3- Environmental Monitoring 2		
	204	WA4-Softcopy Photogrammetry	WB4- Meteorology 1		
	207	WA5-Spatial Data Infrastructure 1	WB5- Disaster Monitoring and Management 1		
	208	WA6-Hyperspectral Data Processing	WB6- Interferometric and Polarimetric SAR 2		
6-Nov R	201	RA1-GIS for Business and Private Industry	RB1- GPS Applications 2	RC1-GIS Application1	RD1-Forestry 3
	202	RA2-Intergration GIS and Remote Sensing 2	RB2- Digital Ortho Image Production	RC2-Agriculture 3	RD2- Automatic Feature Extraction 2
	203	RA3-Geology 2	RB3- Urban Applications 2	RC3-Data Acquisition System	RD3-High Resolution Data Processing
	204	RA4-Mapping system	RB4- Meteorology 2	RC4-Ocean Monitoring 2	RD4-Lidar
	207		RB5- Decision Support System 2	RC5-EMSEA	RD5-EMSEA
	208	RA6-KOMPSAT	RB6 - KOMPSAT	RC6-KOMPSAT	RD6-KOMPSAT
	2nd Floor Lobby		Interactive Session (RINT2)		
7-Nov F	201	FA1- Ecosystem Monitoring 2	FB1- Water Resources and Quality	Closing Ceremony 12:10~12:30 Room 202	
	202	FA2- GIS Application 2	FB2- Natural Resource Management		
	203	FA3- Airbon Sensing 2	FB3- Coastal Zone Monitoring		
	204	FA4- Flood Mapping and Monitoring	FB4- Land Cover/Land Use 2		
	207	FA5- Spatial Data Infrastructure 2	FB5- Disaster Monitoring and Management 2		
	208	FA6- Hyperspectral Sensing	FB6- GIS Data Processing 2		

附錄二：研討會論文發表全文

Implementations of Geographic Information Systems on Sewage Management for Water Resources Protection

Mu-Lin WU
Civil Engineering Deptartment, National Pingtung Univ. of Science and Technology
39-13, TongZong Road, Dali, Taichung County, 41244, Taiwan, ROC
mulinwu@seed.net.tw
Chiou-Hsiung CHEN
Wen-Shang CHOU
Hsiu-Lan HUANG
Taipei Watershed Management Bureau, WRA, MOEA
5, Lane 45, Sec. 1, Peihsin Road, Hsien-Ten, Taipei 231, Taiwan, ROC
showlan@wratb.gov.tw

Abstract: Taipei Watershed Management Bureau (WRATB) is a government agency entitled for water resources protection at two major watersheds in order to provide drinking water for about four millions population in Taipei on a sustainable basis. At WRATB, there are two major public sewage treatment facilities which can convert sewage in each watershed into an acceptable state before they were discharged into rivers. More than 82% of household wastewater have been collected and treated by the two public sewage systems. However, households at remote area still need more effective sewage management prescriptions. The objective of this paper is to implement geographic information systems in order to provide more effective approaches that sewage management can be easier and cost effective. ArcIMS was implemented for Internet browsing and map server of those sewage facilities on personal computers, laptop computers. In the open field, ArcPAD was implemented with personal digital assistant (PDA) such that compact flash type's global positioning systems (GPS) and digital camera can be utilized with PDA. All sewage facilities digital files were convert into ArcMap format files. MapObjects and visual BASIC were used to create sewage application modules to meet every single technician personal flavor. ASP.NET was implemented for Internet database manipulations of all sewage databases. Mobile GIS was the key component of GIS applications in the open field for sewage management on

a basis of house by house. Houses at remote area, which can not cover by the two public sewage systems, were managed by PDA and laptop computers with GPS and digital camera. Sewage management at Taipei Watershed Management Bureau is easier both in the open field and in the office. Integration of GPS, GIS, and PDA makes sewage management in the open field much easier. ArcIMS, MapObjects, ASP.NET and visual BASIC make sewage management can be done in the office and over Internet.
Keywords: Geographic information systems, sewage management, GPS.

1. Introduction

Water quality and quantity is one of very important issues that should be pursued at Taipei Watershed Management Bureau. In order to supply high quality of drinking water on a sustainable basis, water resource protection has to look into all aspects of solutions. There are two major public sewage treatment facilities have been constructed and managed to convert sewage of the two watersheds into an acceptable state before they were discharged into rivers. Household wastewater is subjected to be managed by the two public sewage systems. Households at remote area still need more effective sewage management prescriptions.

The objective of this paper is to implement geographic information systems for sewage management such that water resource protection can be easier and effective.

2. Material and Method

Sewage management has to deal with a lot of maps and databases. Domestic and community wastewater has to look into on a single household basis because it is the main pollution source at WRATB. Existed sewage pipeline network has not covered more than 85% of all household. Maintenance of established sewage facilities and extending collecting pipelines to every single household are the two major problems to be solved.

1) Material

The two major sewage treatment facilities have been created into the databases separately. Sewage collecting pipeline systems including house maps have been created as well. Their map scales are in the range of 1:500 to 1:5000. All maps have been converted into topographic coordinates in order to overlay with maps in the databases. Maps are converted into ArcMap format. Attributes are manipulated into relational database format.

2) Method

Commercial GIS software such as ArcIMS, ArcView, and ArcPAD are the major items to provide GIS functions for sewage management. Programming languages such as Visual Basic, ASP.Net and ADO.Net are used for development of application modules, data manipulations, creation of hyperlinks among maps and their associated attributes. The major ingredients of the whole prescriptions for sewage management are build-to-order and configuration of application modules for single technician both in the open fields and in the office.

Personal digital assistant (PDA) is a very useful and convenient device for field operations. ArcPAD is designed for PDA operations but is also good for personal computer implementations. GPS can work independently with or without PDA. Embedded visual Basic is needed for development of more application modules with PDA. A PDA connected to a GPS device is desired at WRATB. All PDA are running with Windows Pocket PC operating system.

ArcIMS was purchased and used for both Internet operations and intranet operations of sewage management. Databases were mainly created by Excel. They have to convert into Microsoft SQL server and some of them were stored as Internet HTML file format for quick web browsing. With ASP.Net and ADO.Net, traditional database manipulations can be done on web pages.

MapObjects were published by ESRI and come up with several different software languages such as, Visual Basic, Visual C++, Delphi, and so on. With a little bit of programming, MapObjects can provide GIS functions with personal flavor. Some of sewage application modules were created with MapObjects.

smoothly in GIS software.

3. Results and Discussion

1) Household Inventory

Every single household has been investigated and their basic information was created into the databases including address, wastewater collected or not, landowner, types of pipelines, and so on. Which village is also a key component for sewage management.

2) Pumping Station and Sewage Treatment Facilities

Pumping stations including location, number of pumps, capacity, and horse powers were ready for data manipulations and inquiry. More detail information still need to be input into the databases.

The two public sewage treatment facilities are the major components of the whole systems. How to keep them operation on 24 hours a day, and day after day is the top priority. All hardware must keep in good condition and spare parts have to be reached at sufficient amounts and in a short time frame. GIS in this regard is providing some supporting functions in order to make the whole process of sewage treatment facilities can be smooth as long as possible.

3) Sewage Pipeline Network in the Open Fields

Sewage pipeline network in the open fields is the key component that GIS can contribute something in sewage management. Layout maps of pipeline network for every village were stored as GIS databases. A GPS device and a PDA can browse the right sewage maps for a desired place for field operations and data manipulations. Almost all manholes have been located with the help of GPS and their location maps were overlaid with different map layers. Hyperlinks between important sewage pipeline network and their associated attributes can be done smoothly in GIS software.

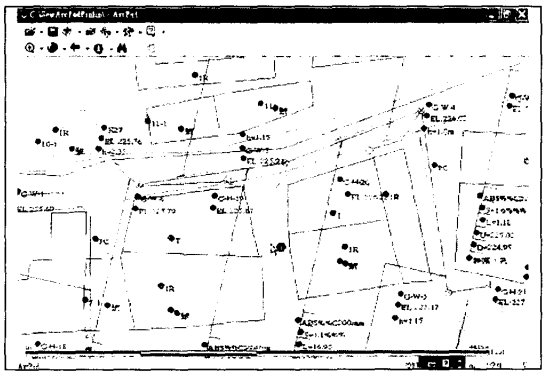

Fig. 1. One portion of sewage maps.

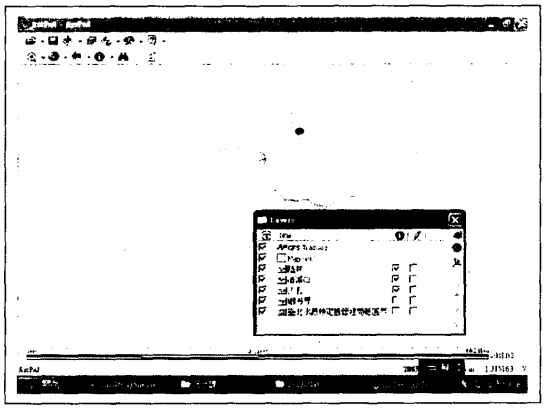

Fig. 2. Manholes overlaid with a township map.

4) Regions that Wastewater has been Collected

Those regions that their wastewater has been collected were managed more like routine works. Maintenance is the most part of jobs done every. Hot springs discharged by hotels and resorts are hot issues to be managed recently. Sewage maps are not the only required maps for management. Parcel maps, house maps, road systems, and contour maps are overlaid quite often. Summary reports usually are a must. Visual Basic is very good for table automatic generation using Microsoft Excel and automatic report generation using Microsoft Word. To convert those information in Excel and Word into databases, Visual Basic is

also a very good programming language.

5) Regions that Wastewater has not been Collected

How to collect the household and public wastewater at remote area with effective management prescriptions is a real challenge at WRATB. Uncollected household has been investigated house by house. GIS can answer so many "what if" questions in order to come up with very good management prescriptions for a specific region. Maps overlay and buffering analysis of GIS can do a nice job in this regard [1]. Budget concern and efficiency can be met simultaneously as well. A long-term project for these regions that wastewater to be collected has been reviewed with the help of GIS and GPS. How many houses to be collected at a given village or region and where are they can be answered quickly by GIS, with the help of maps to show their locations and tables to indicate attributes.

6) PDA for Open Field Operation and Web Browsing

PDA is a very convenient device for open field operation of sewage management, especially, with the help of GPS. Although, it has RAM only 64 MB but power supply good for 12 hours job is quite useful. High resolution color images such as 2 meters and 0.5 meters are no problems to put into PDA as background for field inspection. Some free software can compress one color image from 144 MB into 3 MB such as ECW [2]. ECW is good for ArcView, ArcIMS, and ArcPAD. High resolution satellite images and 0.5 meters resolution orthomaps are very good information to update household databases.
PDA can not use for web browsing without some sorts of cell phone functions such as PHS and GPRS. Two ways communication between servers in the office and PDA in the open fields brings real-time mobile GIS into sewage management. Although, large amount of data manipulations in this manner is confined to bandwidths of PHS and GPRS, a good combination of PDA, GPS, and GIS is very useful for sewage management at WRATB.

4. Conclusions

Taipei Watershed Management Bureau is entitled for water resource protection in order to provide high quality of drinking water for about four millions populations in Taipei. Sewage management is one of many types of jobs has to be done day after day at WRATB. With the help of GIS, GPS, and PDA, sewage management can be done in the open fields and in the office almost identically. Web browsing and mobile GIS are two typical functions that sewage management can be done with more personal flavor. Commercial GIS software is not easy to customize in this manner. With a little bit of programming, application modules for sewage management can be organized in task-oriented and personalized modules. GIS implementations for sewage management at WRATB is not confined to examples mentioned here. More research on GIS implementations for water resource protection are planned in the near future.

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Implementations of Remote Sensing, GIS, and GPS for Water Resources and Water Quality Monitoring

Mu-Lin WU
Civil Engineering Deptartment, National Pingtung Univ. of Science and Technology
39-13, TongZong Road, Dali, Taichung County, 41244, Taiwan, ROC
mulinwu@seed.net.tw

Chiou-Hsiung CHEN
Shiu-Feng LIU
Jiun-Sheng WEY
Taipei Watershed Management Bureau, WRA, MOEA
5, Lane 45, Sec. 1, Peihsin Road, Hsien-Ten, Taipei 231, Taiwan, ROC
jiunshen@wratb.gov.tw

Abstract: Water quantity and quality monitoring at Taipei Watershed Management Bureau (WRATB) is not only a daily business but also a long term job. WRATB is responsible for providing high quality drinking water to about four millions population in Taipei. The quality of drinking water provided by WRATB is among one of the best in Taiwan. The total area is 717 square kilometers. The water resource pollution is usually divided into two categories, point source pollution and nonpoint source pollution. Garbage disposal is the most important component of the point source pollution, especially those by tourist during holidays and weekends. Pesticide pollution, fertilizer pollution, and natural pollution are the major contributions for nonpoint source pollution. The objective of this paper is to implement remote sensing, geographic information systems, and global positioning systems to monitor water quantity and water quality at WRATB. There are 12 water quality monitoring stations and four water gauge stations at WRATB. The coordinates of the 16 stations were determined by GPS devices and created into the base maps. MapObjects and visual BASIC were implemented to create application modules for water quality and quantity monitoring. Water

quality of the two major watersheds at WRATB was put on Internet for public review monthly. The GIS software, ArcIMS, can put location maps and attributes of all 16 stations on Internet for general public review and technical implementations at WRATB. Inquiry and statistic charts automatic manipulations for the past 18 years are also available. Garbage disposal by community and tourist were also managed by GIS and GPS. The storage, collection, and transportation of garbage were reviewed by ArcMap file format. All garbage cart and garbage can at WRATB can be displayed on the base maps. Garbage disposal by tourist during holidays and weekends can be managed by a PDA with a GPS device and a digital camera. Man power allocation for tourist garbage disposal management can be done in an integration of GIS and GPS. Monitoring of water quality and quantity at WRATB can be done on Internet and by a PDA.

Keywords: remote sensing, GIS, GPS, water quality monitoring.

1. Introduction

Water quality and quantity is one of very important issues that should be pursued at Taipei Watershed Management Bureau. In order to supply high quality ofdrinking water on a sustainable basis, water resource protection has to look into all aspects of solutions. Water must be supplied in very high quality manner as well as quite sufficient for general publics. Monitoring water quantity and quality is a daily operation and a long-term job. General public has the right to know detail information about water quality and water quantity on Internet. Garbage disposal by tourist and community is one the main source of point pollution. The nonpoint source pollution is consisting of pesticide pollution, fertilizer pollution, and natural pollution. One of the major sources, hog farm pollution, has been wiped out at WRATB.

The objective of this paper was to implement remote sensing, geographic information systems, and global positioning systems to monitor water quantity and water quality at

WRATB.

2. Material and Method

Water quantity monitoring has been performed since 1988. Monthly measurement and their changes every year have to summit to EPA and open for general public. Some of gauge stations have not measured due to natural disaster such as typhoon. There are 12 stations for water quality monitoring. What have to be sampled and measured are subjected to the guidelines and law set up by EPA. Temperature, pH values, BOD, COD, SS, and so on are items measured periodically.

Garbage disposal is the major components of water pollution at WRATB because so many tourists visit during holidays and weekends. This type of garbage has to be collected and treated efficiently. Monitoring of garbage dumped by tourists is then an important job.

1) Material

Table 1 shows water quality measurements at five sampling stations for a given month. Table 2 indicates water quantity measurements from 1988 to 1992 month by month. Those two types of data have been converted into relational databases and some of them were stored in HTML format for web browsing by general public.

Table 1. Water quality was measured at sampling stations with several elements.

Location	pH	DO (mg/l)	BOD5 (mg/l)	COD (mg/l)	SS (mg/l)
Kuolai	7.0	9.8	0.2	1.0	0.6
Pihu	6.9	9.9	0.5	1.3	0.4
Y.C.P.L	6.8	9.4	0.7	1.6	7.2
Pinlin Bridge	6.9	9.7	0.6	1.4	3.0
Dalin	6.8	9.9	0.6	1.7	1.2

Table 2. Water quantity was measured at one sampling station month by month.

year	JAN	FEB	March	Aprill	MAY
1988	5.113	4.813	4.500	4.465	3.862
1989	7.002	12.060	3.242	4.068	8.105
1990	6.982	4.629	7.952	1.438	4.746
1991	1.786	3.736	1.706	2.299	4.747
1992	5.180	12.200	5.010	5.260	5.520

Figure 1 shows location of all 16 sampling stations for water quality and water quantity monitoring in ArcPAD.

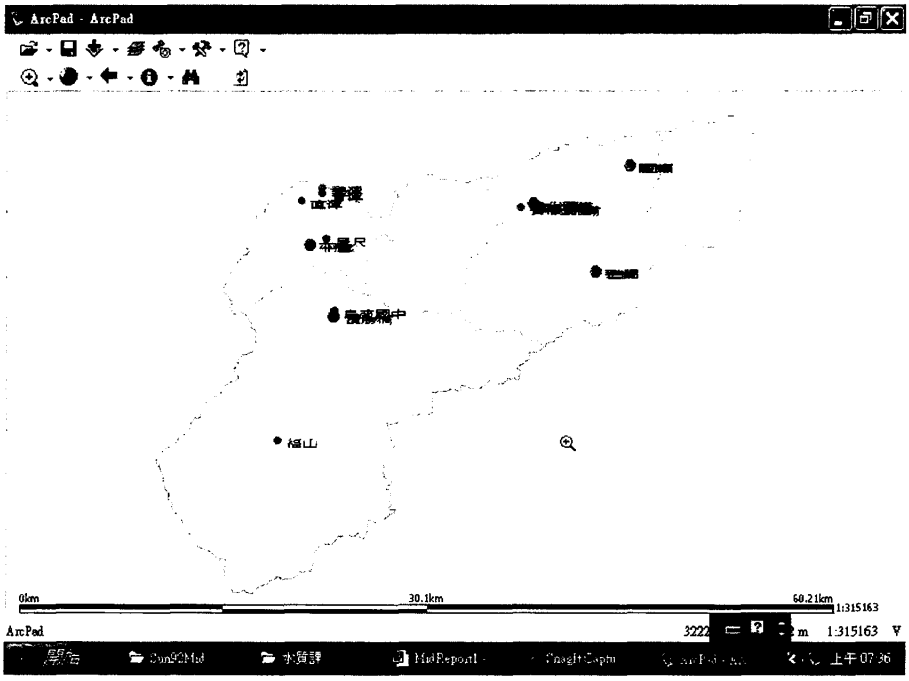

Fig. 1. Location of all 16 sampling stations for water quality and water quantity monitoring.

2) Method

Brand-name GIS software such as ArcIMS, ArcView, and ArcPAD are the major items to provide most GIS functions for water quality and water quantity monitoring at WRATB.

Visual Basic was used to develop more application modules. It is very simple that commercial GIS software can not do all the jobs alone. Programming languages such as ASP.Net and ADO.Net are used for development of application modules, data manipulations,creation of hyperlinks among maps and their associated attributes.

Personal digital assistant (PDA) is used for field operations including water quality and water quantity sampling and garbage management. ArcPAD is designed for PDA operations but is also good for personal computer implementations. It is a very good combination that GPS works together with PDA. Embedded visual Basic is needed for development of more application modules with PDA. PDA is running with Windows Pocket PC operating system.

ArcIMS was purchased and used for both Internet operations and intranet operations. Databases were mainly created by Microsoft Excel and they have to convert into Microsoft SQL server and also stored as Internet HTML file format for web browsing. With ASP.Net and ADO.Net, traditional database manipulations can be done on web pages by general public or government authority. More functions can be added on web pages without making any compromise for security reasons.

MapObjects were published by ESRI with several different software languages say, Visual Basic, Visual C++, Delphi, and so on. MapObjects can provide GIS functions with personal flavor but requires more computer efforts. Some of application modules were created with MapObjects such that they can be more user-friendly and cheaper.

3. Results and Discussion

1) Water Quality Monitoring

Many items of water quality have to be measured at headquarters of WRATB. Their measurements were then manipulated with Microsoft Excel. Standard procedure has been set up for the whole process. GIS can provide functions for field data collection, database manipulation,

hyperlinks between location and its associated attributes, and map overlay with other map layers. When water pollution was detected, it can be analyzed with the help of GIS to come up with some management prescriptions. Because landslide maps, sewage facilities maps, land use maps, and high resolution images can be overlaid with the water sampling station map for further inspection.

2) Water Quantity Monitoring

Water quantity monitoring is much like the water quality monitoring but it is much simple. Some of the sampling stations have been converted into automatic process. A little bit of programming has to read the data set and input into the existed databases. Statistic table generation and statistic charts generation were provided by application modules in Visual Basic.

Both water quantity and water quality monitoring require satellite images to cover a single watershed. SPOT satellite images with 20 meters resolution have been purchased and used as background information. Higher resolution satellite images such as 2 to 3 meters are more useful. Chinese Sat-II will be launched in the near future that will be implemented for water quality and water quantity monitoring at WRATB.

3) Garbage Management

Garbage management can be divided into two types of job. Community garbage collection and transportation is more like a routine work can be managed without much surprise. Figure 2 shows locations of all garbage can and garbage cart at WRATB. Every single garbage can or garbage cart has its associated attributes in the databases ready for further inquiry and analysis. How many garbage can and garbage cart within a village or at a scenic attraction can be answered by GIS.

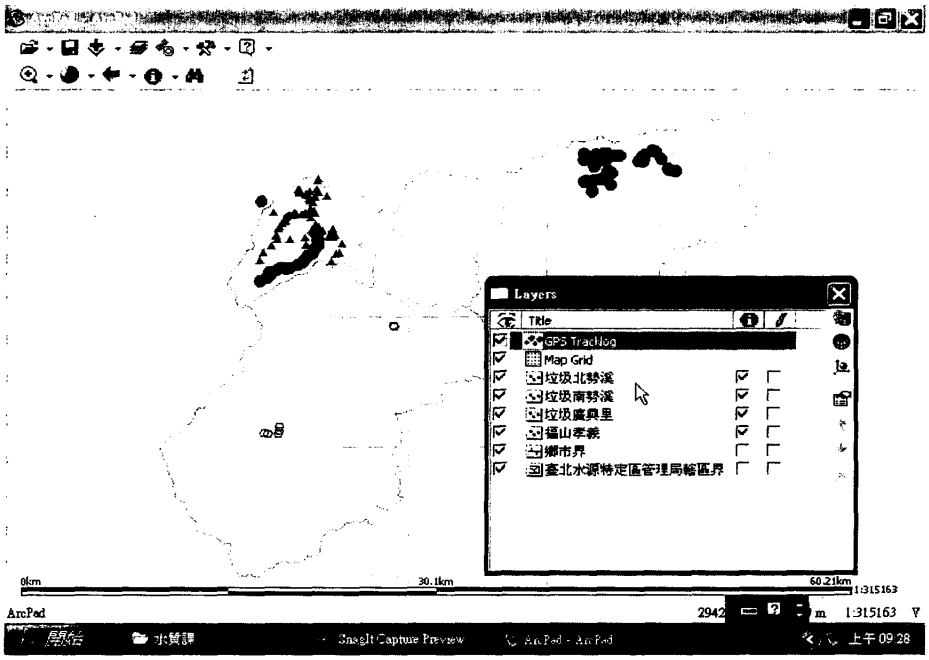

Fig. 2. Location map of garbage can and garbage cart at WRATB.

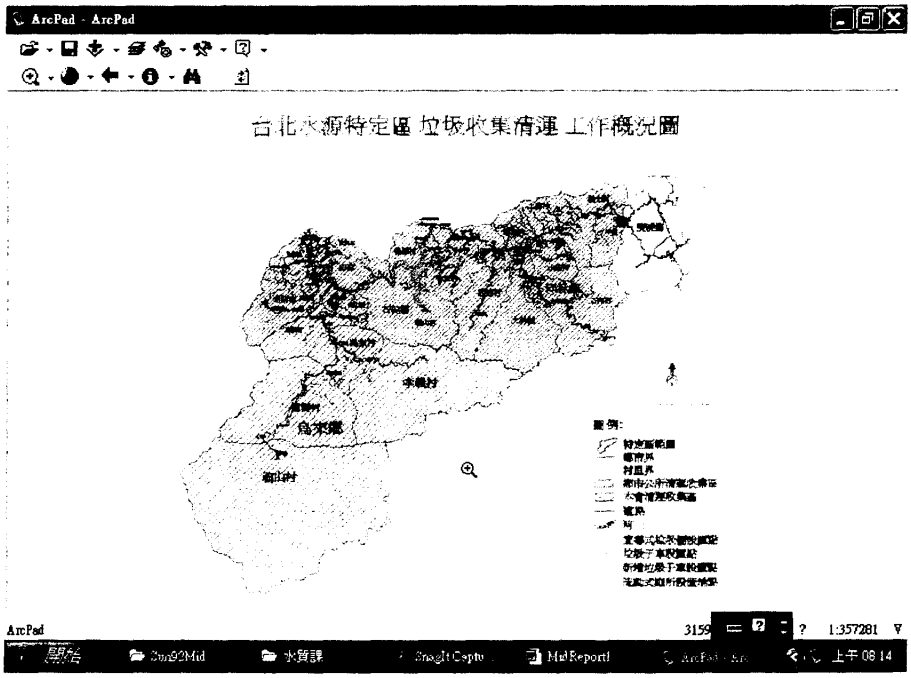

Fig. 3. Garbage transportation route at WRATB.

Figure 3 is a garbage transportation route map at WRATB. It was prepared with the help of GPS.

Garbage disposal by tourists during holidays and weekends is a challenge that requires close monitoring. Man power allocation at different sites has to prescribe according to this type of garbage monitoring. PDA and GPS work together in the open fields can provide very nice garbage information in real time. A compact flash type of digital camera can work with PDA providing color images on the right place. With the help of PHS and GPRS, PDA can be used for web browsing and provides real-time mobile GIS functions for garbage management.

4. Conclusions

Taipei Watershed Management Bureau is the only one government agency in Taiwan set up for water resource protection with full legal authority. It is more like a river valley authority in order to provide high quality of drinking water for about four millions populations in Taipei. Water quality and water quantity monitoring is a long-term process that require more sophisticate and effective approaches. GIS, remote sensing, GPS, and PDA can work together providing more cutting-edge approaches for water resource protection at WRATB.

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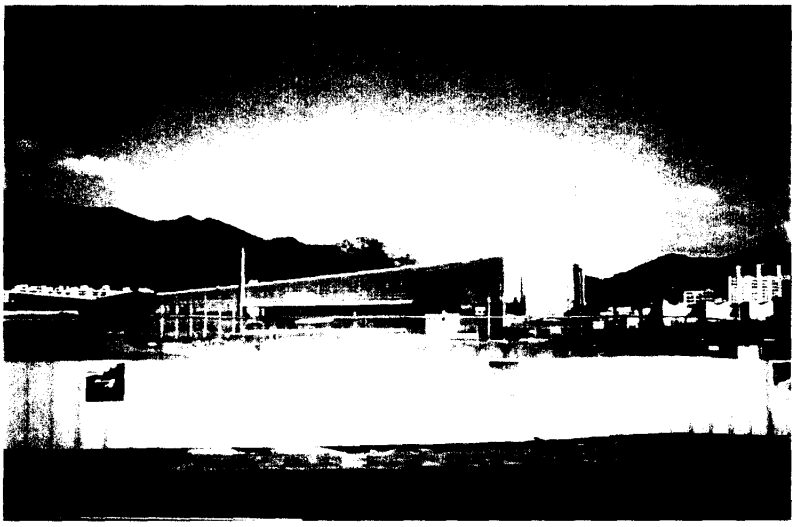
附錄三：研討會照片



大會會場外觀

會場前合影

（左起：伍木林教授，陳局長久雄，黃副工程司琇蘭，魏工程員俊生）

黃副工程司琇蘭攝於發表的論文前

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經濟部水利署臺北水源特定區管理局
台北縣新店市北新路一段45巷5號4樓
總機：(02)29173282
傳真：(02)29180335