**The Application of Web-based and Spatially Engineering Management System**

**Shu-Shin Chuang Tien-Yin Chou Mei-Shin Chen Wen-Shan Lo Yu-Lin Cheng** *
***GIS Research Center, Feng Chia University**

**ABSTRACT**

The purpose of this study is to apply the Internet technology spatially to develop "Digital Engineering Management and Evaluation Systems". It uses GIS to spatialize the site of slope land engineering constructions and overlay the maps, which are in the database established by Soil and Water Conservation Bureau in Taiwan. That database contains debris flow information, topographic map, aerial photograph and satellite image etc. Users can easily access the geographical distribution of engineering constructions, query engineering scheduled progress and the status of construction from Internet service. This study also integrates PDA and GPS to develop a system that can offer investigator to position and record the exact coordinate, query maps and attribute data in real-time and on-site. And the system can transmit the information to database server directly. This study provides a convenient mean to update and maintain the engineering database, and improves the efficiency of hazard management on slope land.

**KEY WORDS:** Internet, Engineering Management and Evaluation, GIS, PDA, Server, hazard of slope lands

## 1. INTRODUCTION

Computer science has greatly upgraded nowadays, especially the Internet communication, which plays an important role for information exchanging. Moreover, the Internet is the essential media for government departments to establish "e" liked functionality. To effectively handle the Soil and Water Conservation Bureau's projects, and to meet the goal of e-government, we build the "Soil and Water Conservation Engineering Management System" upon world-wide-web technology. Every engineering department can browse the system through WWW to report projects' progress. The management departments of Soil and Water Conservation Bureau can Real-Time handle every project's progress and situation by this system; fewer paper wastes, better effectiveness promotes.

The "Soil and Water Conservation Engineering Management System" uses the feature of GIS (Geographic Information Systems) concept to process engineering data. All projects' positions are spatial processed and co-operating with disaster-database (built by SWCB over the years, including mudflows and landslides underflow survey, collapse survey, the conformation of precaution against natural calamities, …etc). Every engineering department can control positions, progress, and working situations of all projects by this integrated system.

Investigators use PDA to locate and query related attribute data of the engineering system map. They can also upload the investigation to the server into disaster database. This function provides a convenient way to upgrade and maintain database. Depending

on the functionalities described above, the system can greatly raises the efficiency of slope disaster management, and accomplishes the mobile engineering management.

## 2. DEVELOPMENT METHODS

### 2.1 Soil and Water Conservation Engineering Management System

This research relies on Web-Based structure to build the whole System. We adopt IDEF methodology for functionality analysing and system development, shown as Figure 1. We inquire and discuss with conservation bureau's business worker to list the requirements and functions that the system must provide, shown as Figure 2. Each execution unit of engineering can use the system anytime to type engineering schedule over Internet, and reports the engineering situation regularly; moreover, the information saved in "Soil and Water Conservation Engineering Management System" database of SWCB server for the undertaker to conveniently control the schedule and geographical distribution.

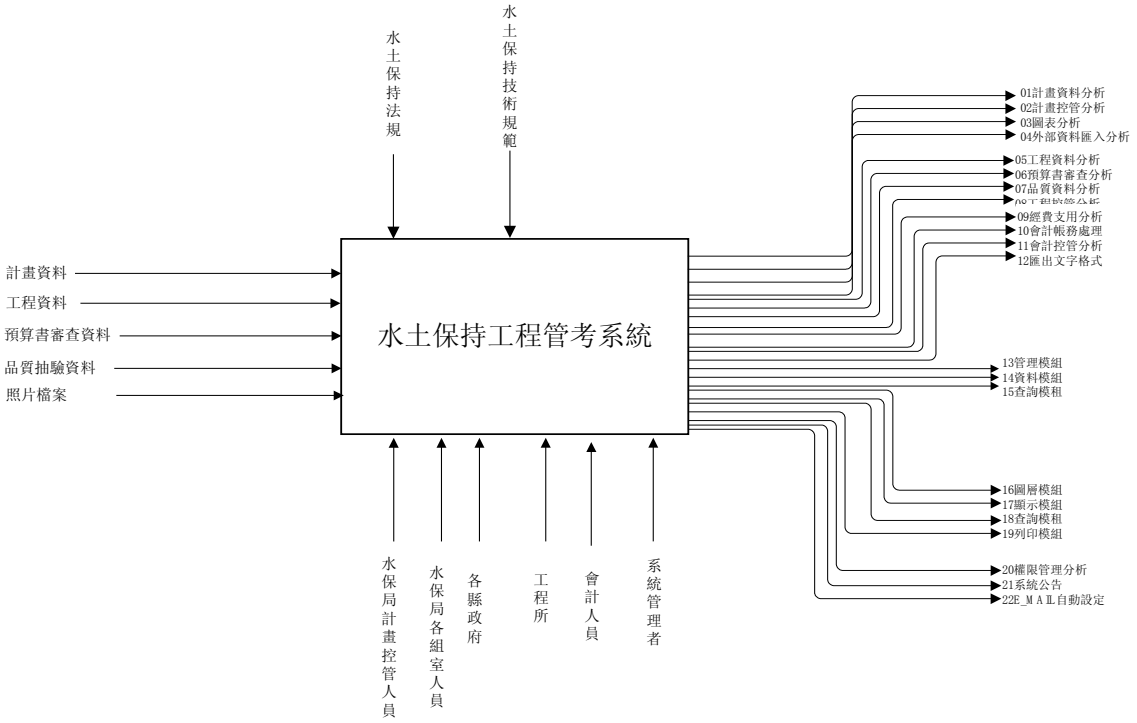


Figure 1. IDEFO of Soil and Water Engineering Management System

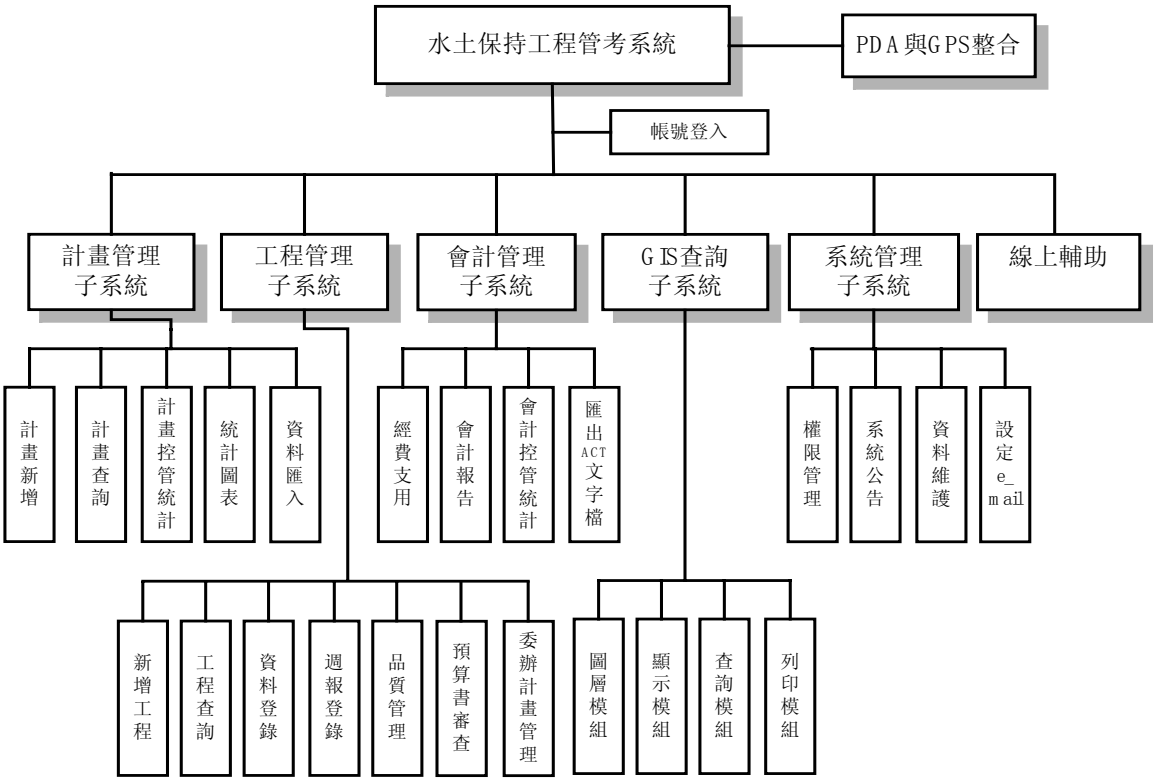


Figure 2. Functionality Structure of Soil and Water Engineering Management System

## 2.2 Slope-Land GIS over Internet

Depending on the GIS Query sub-system (includes traffic database, river database, territory area, earth surface data, index data, basic images, disaster prevention and engineering facilities, shown as Figure 3), which is built by WWW-GIS system, the "soil and water conservation bureau" can provide the whole bureau, other government departments, and common people to locate positions, to query graph and related attribute data, shown as Figure 4.

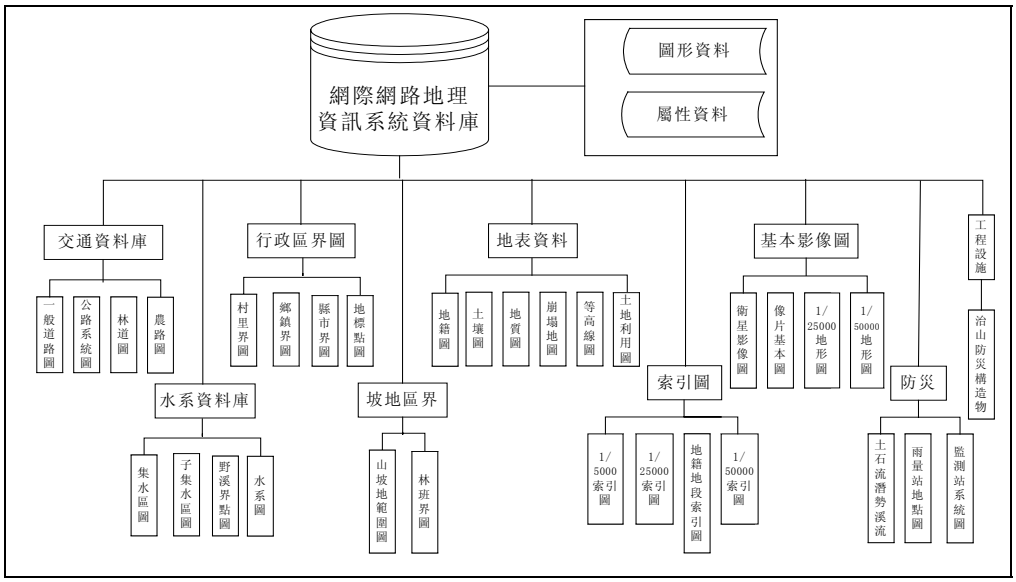


Figure 3. Database Structure of Internet GIS

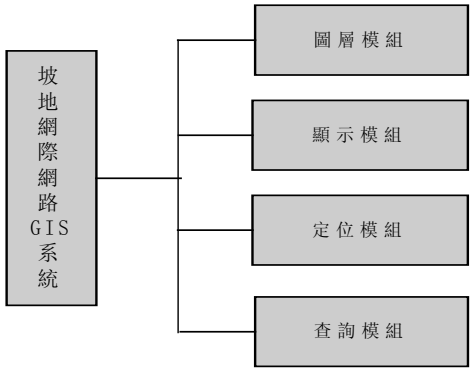


Figure 4. Functionality Structure of the Internet GIS System

### 2.3 PDA Engineering Management System

The PDA sub-system is Mainly built by Microsoft Embedded Visual C++, and is placed on Compaq iPAQ PDA (WinCE platform). The soil and water management map data stored inside PDA is shape-file format; moreover, the GPS module is established by CF extension module plus GPS receiver module. It's light-weighted and convenience for the investigators.

The "PDA Engineering Management and Reporting System" provides the soil and water conservation bureau's workers to upload the live pictures onto server by the PC side sub-program, when they photograph pictures at the working place; the system flowchart and structure are shown as follows:

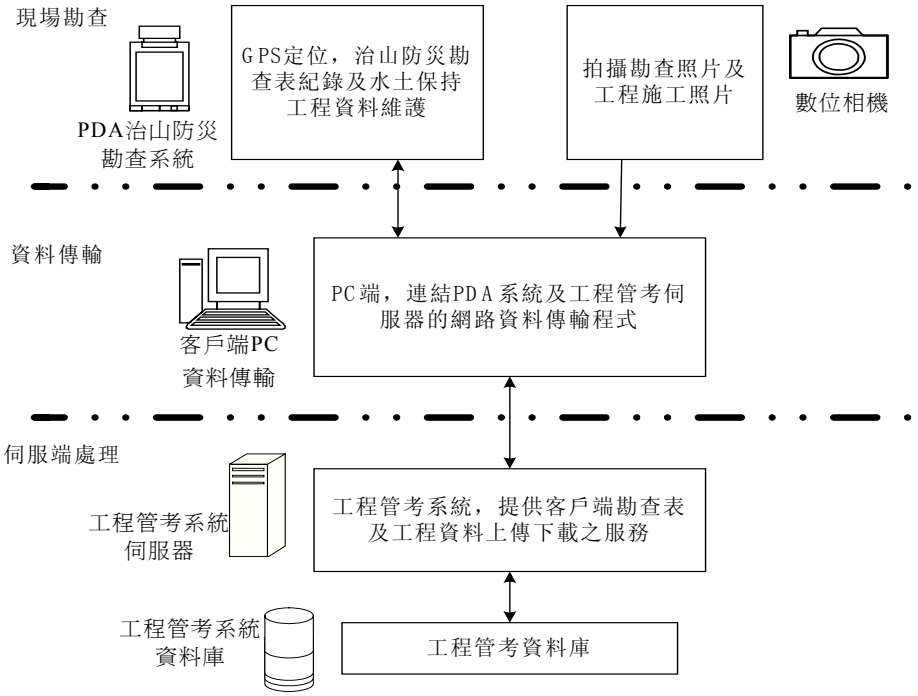


Figure 5. PDA System Flowchart

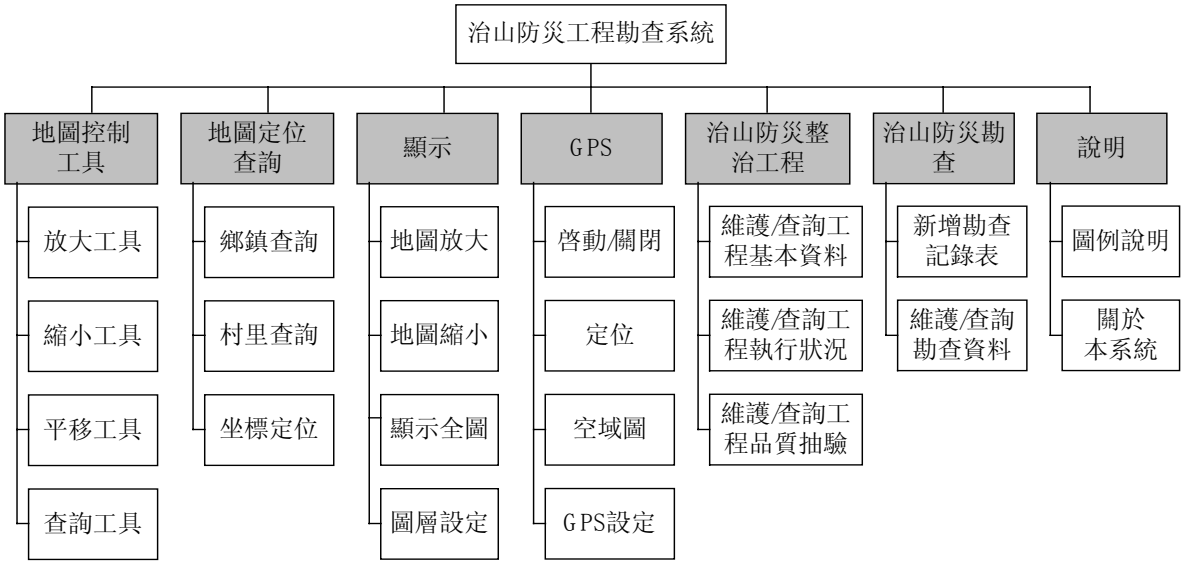


Figure 6. PDA Functionality Structure

## 2.4 Full System Architecture

This research is based on the "Soil and Water Conservation Management System", integrated with the "Internet GIS System" and the "PDA Engineering Management System" to establish a 3-tier structure, the whole network structure is shown as Figure 7.

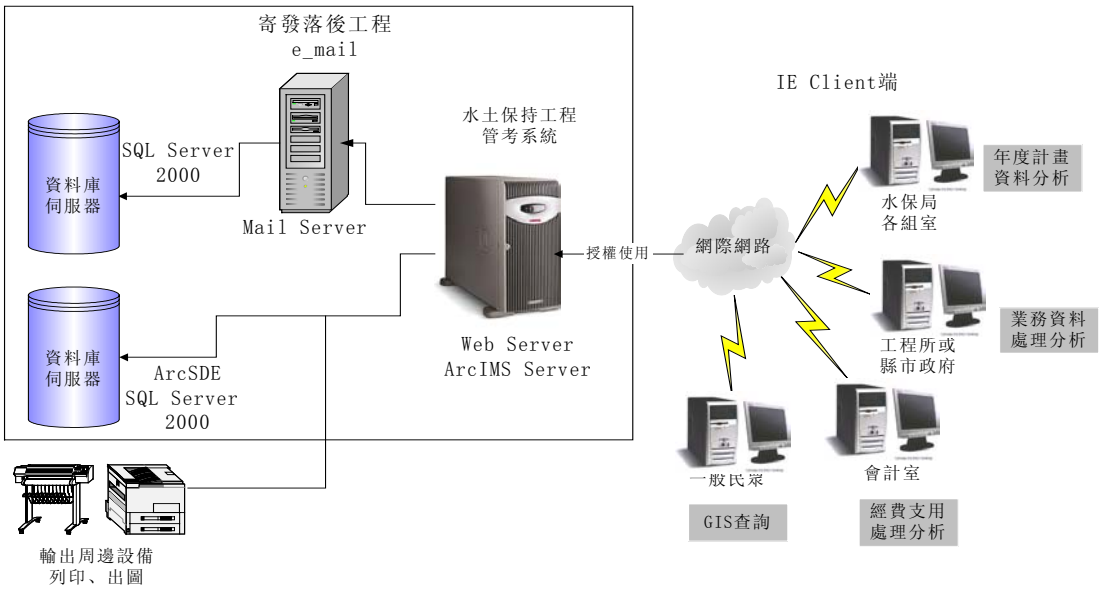


Figure 7. Full System Structure of Soil and Water Engineering Management System

# 3. ACHIEVEMENTS

## 3.1 Soil and Water Conservation Engineering Management System

### 3.1.1 Plan Management

To provide all levels of Soil & Water Conservation Bureau management departments to handle every plan progress and budget accounting, the system provides users to export data into MS-Excel format and produces budget pie and Progress-Curved-Line simultaneously, shown as Figure 8 and Figure 9.

計畫執行狀況統計表

| 項次 | 年度 | 計畫名稱 | 子計畫名稱 | 子計畫經費(千元) | 實際執行 | | | 執行情形 | | | | | | | 發包情形 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 件數(C) | 工程核定經費(千元) | 發包贈餘款(千元) | 已完工(D) | 未完工(E) | 完工率(%)=D/C | 實際進度(%) | 進度超前(件) | 進度尚待(件) | 嚴重落後(件) | 已發包(F) | 未發包(G) | 發包率(%)=F/C |
| 1 | 92 | 土石流災害及農漁村環境改善 | 加強農村地區環境改善 | 609,000 | 239 | 600,500.000 | 76,361.440 | 0 | 239 | 0.00% | 11.77% | 0 | 239 | 0 | 14 | 225 | 5.86% |
| 2 | 92 | 土石流災害及農漁村環境改善 | 非農地重劃區農路改善及維護 | 1,182,080 | 647 | 892,430.000 | 99,737.951 | 0 | 647 | 0.00% | 9.00% | 0 | 647 | 0 | 0 | 647 | 0.00% |
| 3 | 92 | 土石流災害及農漁村環境改善 | 擴大在地人參與土石流防治 | 926,920 | 382 | 828,220.000 | 116,623.475 | 1 | 381 | 0.26% | 11.04% | 1 | 381 | 0 | 35 | 347 | 9.16% |
| 4 | 92 | 水土保持管理 | 水土保持植生綠化 | 11,784 | 6 | 6,600.000 | 901.303 | 0 | 6 | 0.00% | 2.82% | 0 | 6 | 0 | 1 | 5 | 16.67% |
| 5 | 92 | 水土保持管理 | 坡地保育利用公共設施計畫 | 62,100 | 119 | 40,886.000 | 7,230.146 | 78 | 41 | 65.55% | 41.10% | 0 | 119 | 0 | 82 | 37 | 68.91% |
| 6 | 92 | 水土保持管理 | 農村綜合發展建設 | 45,810 | 25 | 53,228.000 | 5,297.776 | 1 | 24 | 4.00% | 8.05% | 0 | 25 | 0 | 4 | 21 | 16.00% |

Figure 8. Statistic Table of Plan Executing Progress

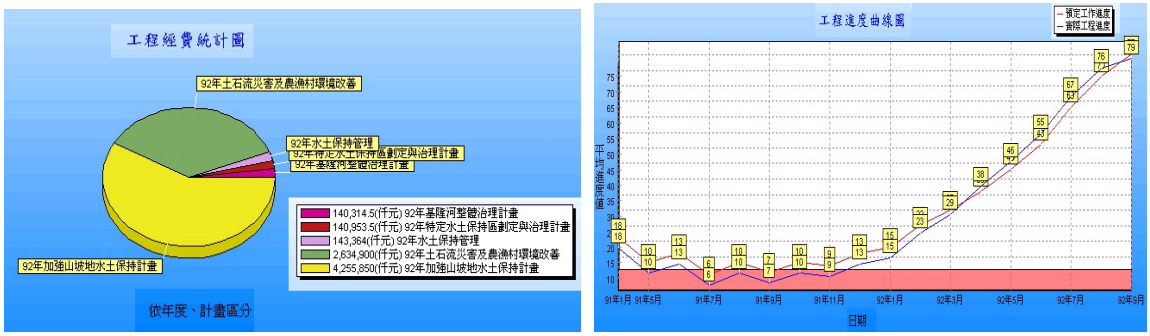


Figure 9. Graph & Table Analysis

### 3.1.2 Engineering Management

Users can register engineering data, progress situation per month, budget enforce, upload engineering picture, etc via the Internet. The system automatically checks whether the data is correct or not by seeking engineering location and user input. After a record is inserted, the system will automatically calculates the month accounting table base on the newest data record-set, and shows each engineering contents belonged to the engineering.


Figure 10. Engineering Executing Contents

### 3.1.3 Accounting Management

The system purpose is to make engineering management and assess automatically, according to accounting flowchart, to provide accounting user to make payment budget,

to register accounting reports, to charge against accounting, to reserve budget and to integrate GBA.

年度歲出保留經費明細表

| 保留 | 工程序號 | 工程名稱 | 工程款 | | 自辦工程費(含空污費) | | 委外測設監造費 | | 完工比 | 保留原因 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 預算數 | 實付數 | 預算數 | 實付數 | 預算數 | 實付數 | | |
| ◉保留 ○不保留 | 91WS11-090 | 馬衛仔溪護岸工程 | 2,520,000 | 2,520,000 | 22,000 | 7,412 | 34,339 | 34,258 | 100% | 工期未屆(2002/7/14開工,91/10/15展期完工) |
| ◉保留 ○不保留 | 91WS11-091 | 竹田村大竹圍下排水工程 | 2,635,000 | 2,635,000 | 13,500 | 7,729 | 43,229 | 43,229 | 100% | 工期未屆(2002/7/14開工,91/09/15展期完工) |
| ◉保留 ○不保留 | 91WS11-092 | 永豐蝕溝控制工程 | 2,310,000 | 2,310,000 | 10,485 | 6,768 | 54,637 | 54,637 | 100% | 工期未屆(2002/7/14開工,91/09/30展期完工) |
| ◉保留 ○不保留 | 91WS11-093 | 馬立雲二期排水工程 | 2,077,000 | 2,077,000 | 15,000 | 6,385 | 31,587 | 30,141 | 100% | 工期未屆(2002/7/14開工,91/09/15展期完工) |
| ◉保留 ○不保留 | 91WS11-094 | 樹湖一號橋上游無名溪二期蝕溝控制工程 | 1,430,000 | 1,430,000 | 9,500 | 4,193 | 20,618 | 20,617 | 100% | 工期未屆(2002/7/14開工,91/09/15展期完工) |
| ◉保留 ○不保留 | 91WS11-095 | 龜奄野溪整治工程 | 1,830,000 | 1,830,000 | 10,800 | 5,343 | 32,906 | 32,906 | 100% | 工期未屆(2002/7/14開工,91/09/30展期完工) |
| ◉保留 ○不保留 | 91WS13-002 | 東興部落崩塌處理工程 | 2,350,000 | 2,350,000 | 13,800 | 6,834 | 41,595 | 41,595 | 100% | 工期未屆(2002/12/29開工,92/03/20展期完工) |

Figure 11. Reserved Budget Detail Table

花蓮縣政府

行政院農業委員會水土保持局九十二年度工程執行狀況表

計畫名稱及編號：加強山坡地水土保持計畫-治山防災

| 工程編號 | 工程名稱 | 工程預算(核定預算) | 辦理情形(Y) | | | | 執行狀況 | 總工程費 | | | | | | | | | 實付數(水保局負擔款部分) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 自行測設監造 | 委外測設但自行監造 | 委外測設及監造 | 自行測設但委外監造 | | 發包工程費或結算工程費(含變更設計金額)(1) | 行政費用(含保險、包商稅雜等按8%計列)(2) | 可提列工程管理費之工程款(3)=(1)-(2) | 供給材料費(4) | 自辦工程(含空污費)(5) | 工程管理費 | | 委外測設監造費(8) | 小計(9)=(2)+...(8) | 經費來源 | | 工程費(含變更設計及驗收扣款)(10) | 供給材料費(11) | 自辦工程(含空污費)(12) | 執行單位工程管理費(13) | 委外測設監造費(14) | 小計(10)+(14) |
| | | | | | | | | | | | | | 執行單位(6) | 水保局(7) | | | 水保局負擔款 | 縣市配合款 | | | | | |
| 92ws02-200 | 高寮竹林溪野溪整治工程 | 4,000,000 | | | V | | 已結算 | 2,370,000 | 189,600 | 2,180,400 | 0 | 12,419 | 52,330 | 13,082 | 106,452 | 2,554,283 | 2,554,283 | - | 2,370,000 | 0 | 6,794 | 52,330 | 106,451 | 2,535,5 |
| 92ws02-201 | 東豐二層坪野溪整治工程 | 4,000,000 | | | V | | 已結算 | 2,080,000 | 166,400 | 1,913,600 | 0 | 12,156 | 45,926 | 11,482 | 102,893 | 2,252,457 | 2,252,457 | - | 2,080,000 | 0 | 5,966 | 45,926 | 39,288 | 2,171,1 |
| 92ws02-203 | 羅萬溪利民橋下游整流工程 | 4,000,000 | | | V | | 已結算 | 2,578,000 | 206,240 | 2,371,760 | 0 | 14,000 | 56,922 | 14,231 | 168,431 | 2,831,584 | 2,831,584 | - | 1,833,785 | 0 | 0 | 56,922 | 67,566 | 1,958,2 |
| 92ws02-204 | 大豐14鄰蝕溝控制工程 | 2,000,000 | | | V | | 已結算 | 1,430,000 | 114,400 | 1,315,600 | 0 | 7,000 | 31,574 | 7,894 | 96,765 | 1,573,233 | 1,573,233 | - | 1,430,000 | 0 | 4,204 | 31,574 | 39,512 | 1,505,2 |
| 92ws02-205 | 大全二至三鄰野溪整治工程 | 3,533,000 | | | V | | 已結算 | 2,449,000 | 195,920 | 2,253,080 | 0 | 13,000 | 54,074 | 13,518 | 196,117 | 2,725,709 | 2,725,709 | - | 0 | 0 | 0 | 15,843 | 74,881 | 90,7 |
| 92ws02-206 | 南華16鄰野溪整治工程 | 2,000,000 | | | V | | 已結算 | 1,130,000 | 90,400 | 1,039,600 | 0 | 6,973 | 24,950 | 6,238 | 60,565 | 1,228,726 | 1,228,726 | - | 1,130,000 | 0 | 3,318 | 24,950 | 22,235 | 1,180,5 |
| 92ws02-207 | 富南虎頭溪整治工程 | 3,000,000 | | | V | | 已結算 | 1,770,000 | 141,600 | 1,628,400 | 0 | 5,175 | 39,082 | 9,770 | 108,831 | 1,932,858 | 1,932,858 | - | 0 | 0 | 0 | 39,082 | 41,554 | 80,6 |
| 92ws02-208 | 吳阿再溪富榮橋上游整治工程 | 2,500,000 | | | V | | 已發包 | 1,680,000 | 134,400 | 1,545,600 | 0 | 7,300 | 37,094 | 9,274 | 95,549 | 1,829,217 | 1,829,217 | - | 0 | 0 | 0 | 37,094 | 33,554 | 70,6 |

Figure 12. Situation Table of Engineering Execution

## 3.2 Internet GIS

This sub-system provides user to set graph layers, includes area side line, disaster area, debris area, tumbled land area, landform map, satellite image…etc, and then processing zoom-in, zoom-out, flatness move, picture linking, attributes query, print, etc. Users can use advanced functionalities which includes engineering contents query, statistic, locating, etc.

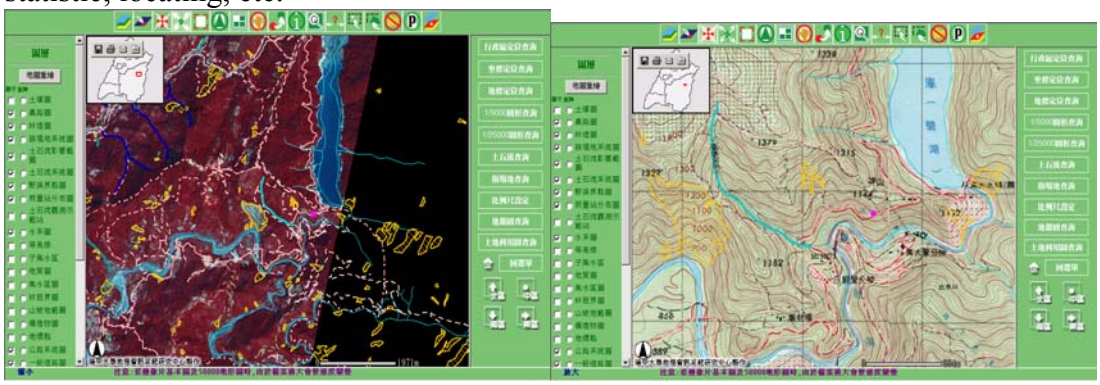

Figure 13. Satellite Image and 1/25000 Landform Graph

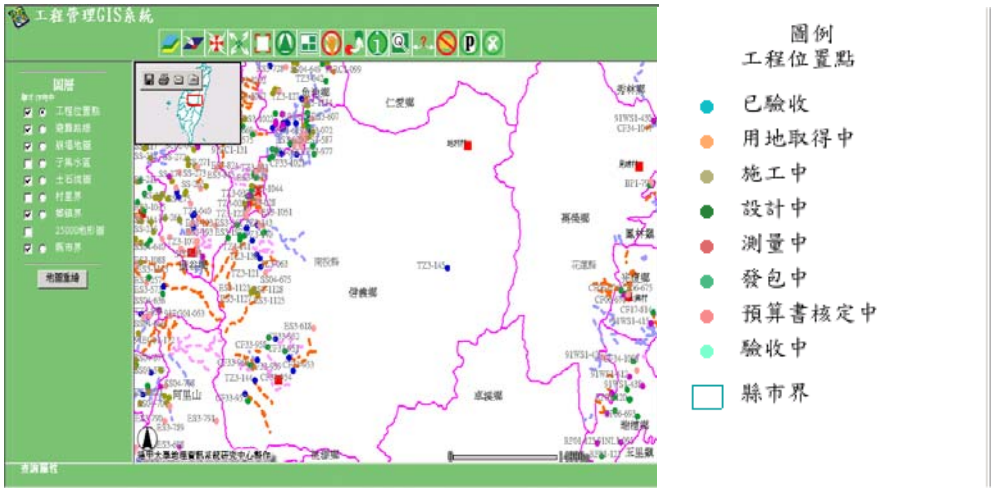


Figure 14. Engineering Position Query

### 3.3 Integration of PDA, GPS and Digital Camera

The Soil and Water Conservation Bureau has made the full system on-line. This running system integrates with the PDA, GPS and digital camera to achieve Economy, Convenience, and powerful functionality. The engineering executing departments can register data through the web site, download engineering data into PDA, take the PDA to the engineering place to record status directly, then upload those newest data onto server side; greatly increase manage effectiveness.

#### 3.3.1 Coordinate Location

Users can directly input X,Y values or input X,Y by GPS receiver, then run the locating function to display graph related to the specified coordinate.

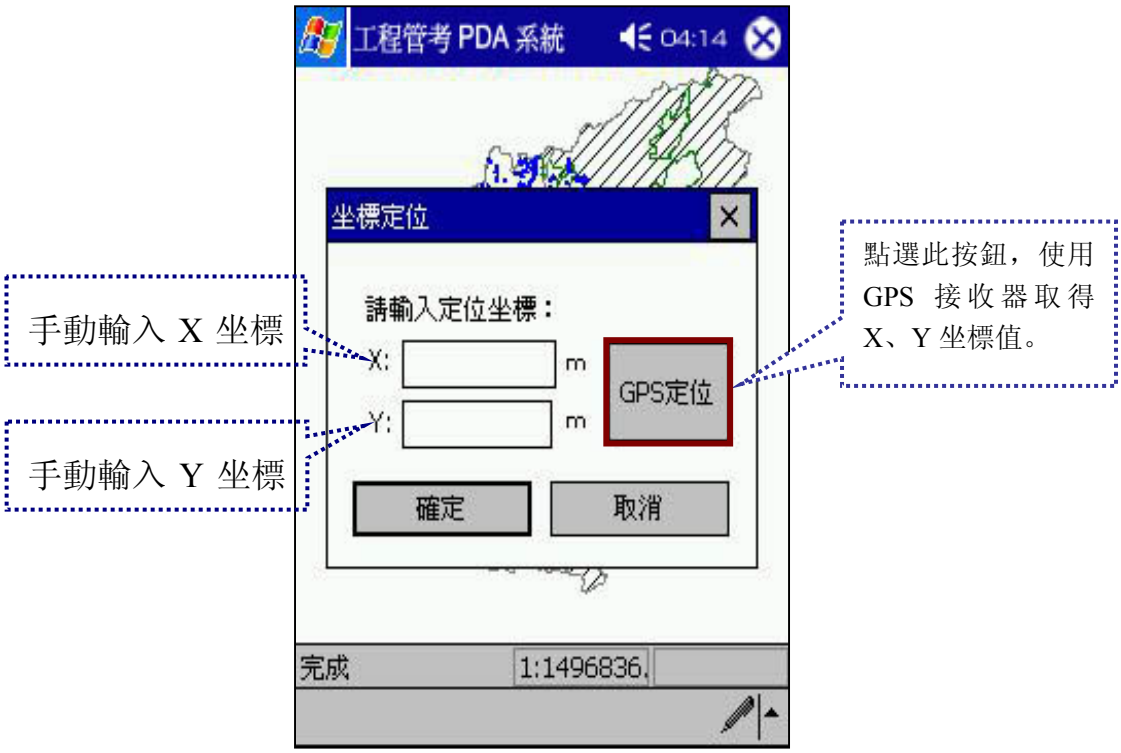

Figure 15. Coordinate Locating

3.3.2 Engineering investigating

The full system provides query functionality, i.e. investigators could only use the convenient interface to select wide range data, and see the related engineering contents, includes pictures, record tables, accounting statistics…etc. Moreover, users can directly hit the displaying monitor to get the located engineering data, which belongs to the hit monitor position.

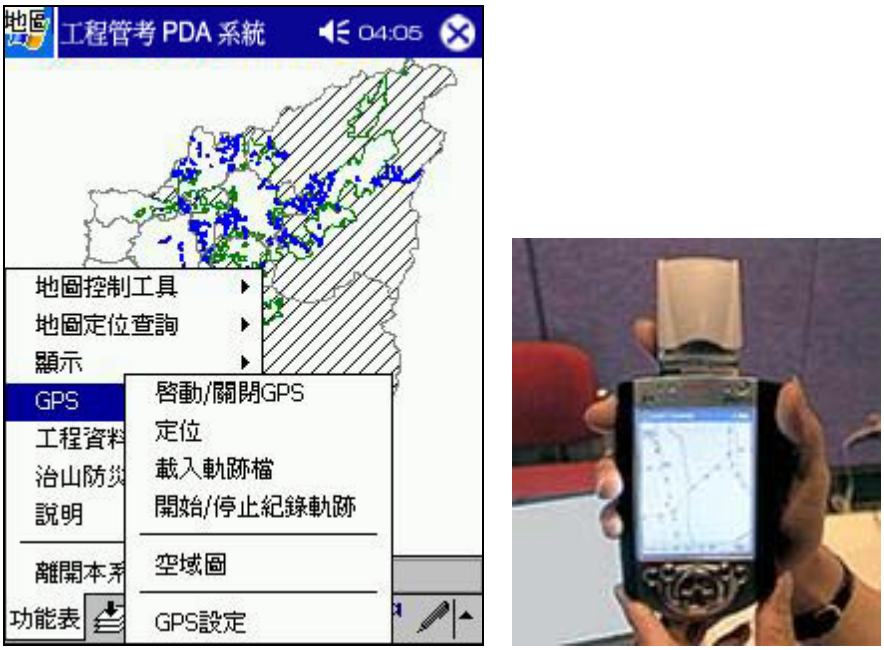


Figure 16. Receiving X/Y Coordinate Value

3.3.3 Engineering Data Maintenance

The engineering data maintenance function provides investigators to easily check all engineering's current status, quality, and progress.

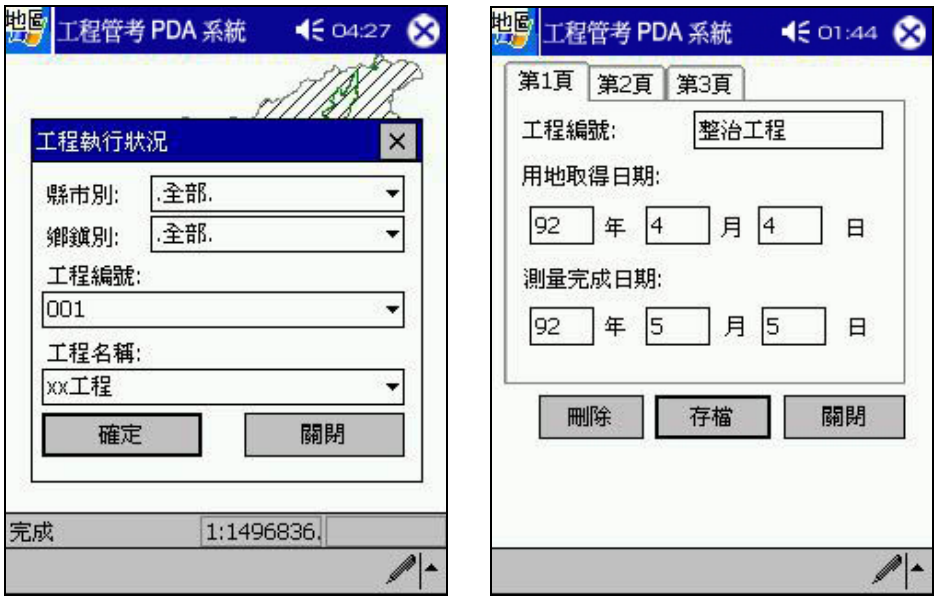


Figure 17. Maintenance of Engineering Executing Status

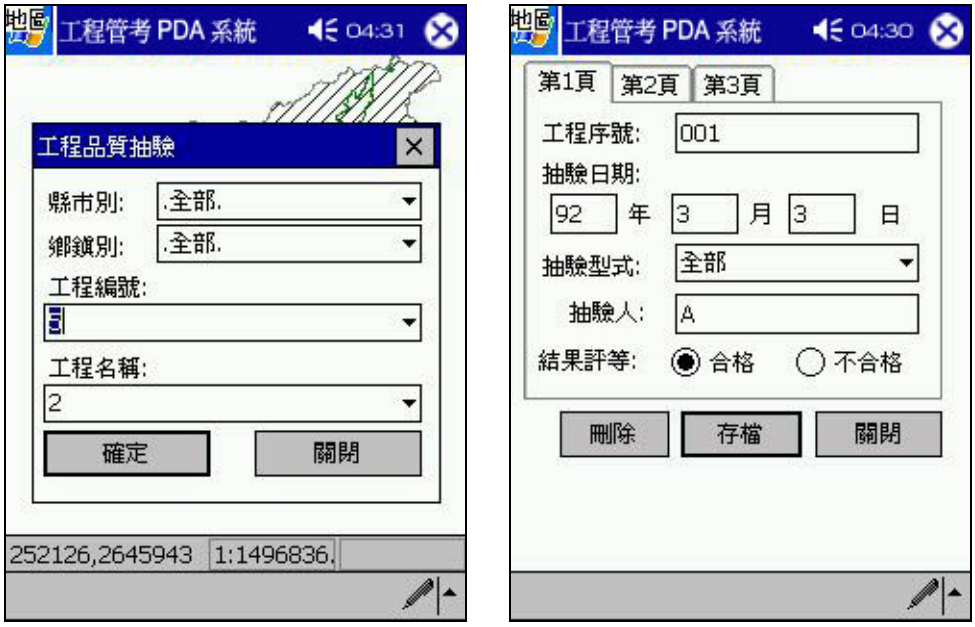


Figure 18. Qualification and Maintenance of Engineering Quality

### 3.4 System Integration

Our research uses the management system as the core, to provide the convenient user interface, and use suitable program language to build data transmission procedure. Then integrates Internet GIS and PDA sub-system and the core system to a full omnibus system that attracts investigators to trust and rely on this system.


Figure 19. Data Transmission User Interface

## 4. CONCLUSION

Integrating business functionality with accounting examination processes of SWCB's engineering plan and commission plan to build informational operating model, the business section can record the schedule on time in internet to save the data in the

database of SWCB server, inquire the related data or print the forms on line, and reduce key in repeat; therefore, directors can handle the executive rate and geographical distribution, and full-fill the engineering schedule management.

The system uses PDA, GPS and on-the-spot survey, so that the executive can key in survey data on time; besides, the system integrates with "Engineering Management System" to shorten the time of data key in, and raise the efficiency of engineering survey and management.

Each engineering executive can use the system anytime to record engineering schedule by internet, and report regularly the engineering situation; moreover, the information saved in "Soil and Water Conservation Engineering Management System" database of SWCB server for undertaker to control the schedule and geographical distribution.

## 5. REFERENCE


Chen R.S. , (2000), PDA Application Software Develop Environment Platform, New Electronics Technology Vol.177.

Zhang Z.F., X.Y. Ke, Personal Data Management System for Personal Digital System, Computer and Communication Vol.87

GIS Center,(2000), ArcView 3D World.

GIS Center,(2000), Geographic Information System of Accounting Plan Final Paper for Disaster Reviving Engineering Tao-jr Typhoon.

GIS Center,(2000),Data Integration of Mountain Slope Disaster and Internet Geographic Information Building Paper.

GIS Center,( 2001), Internet Geographic Information System、Debris Disaster Information System、Management & Assessing System、Maintenance & Updating for Meteorology Data Transmission System and Final Reporting for Producing Disaster Prevention Map.

Chou T.Y., Yen M.L. and Zhong L.K,(2000), GIS Theory and Application.

Richard C. leinecker, Visual C++ 6 Bible.